

AD-A163 315

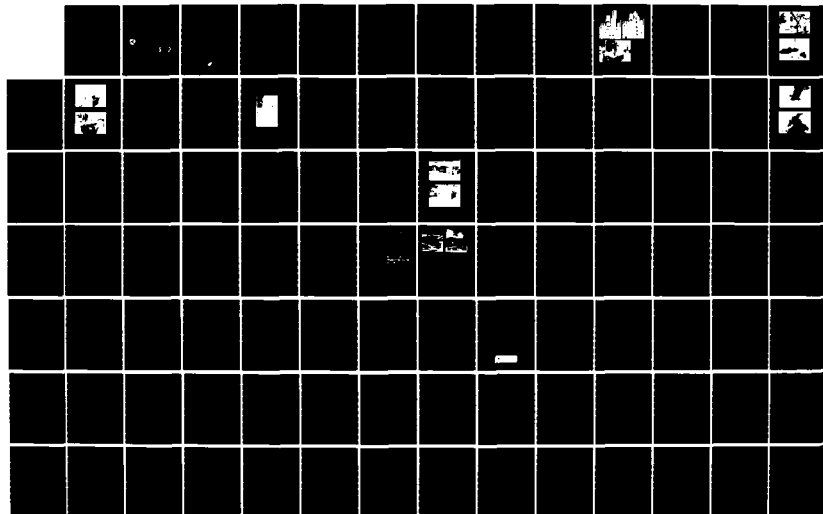
FIRE RESISTANCE TESTING OF BULKHEAD AND DECK
PENETRATIONS(U) COAST GUARD RESEARCH AND DEVELOPMENT
CENTER GROTON CT D E BEENE ET AL. OCT 85 CGR/DC-5/85
USCG-D-33-85

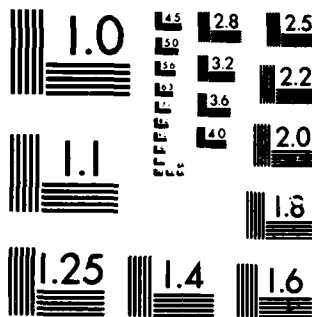
1/4

UNCLASSIFIED

F/G 13/12

NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

12

Report No. CG-D-33-85

FIRE RESISTANCE TESTING OF BULKHEAD AND DECK PENETRATIONS

AD-A163 315

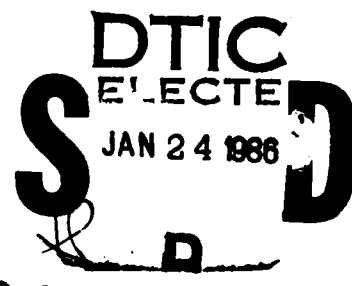
D.E. BEENE, JR.
and
J.H. HOWES

U.S. COAST GUARD RESEARCH AND DEVELOPMENT CENTER
AVERY POINT, GROTON, CONNECTICUT 06340-6096



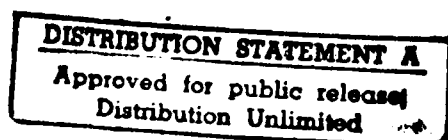
FINAL REPORT
OCTOBER 1985

This document is available to the U.S. public through the
National Technical Information Service, Springfield, Virginia 22161



Prepared for:

U.S. Department Of Transportation
United States Coast Guard
Office of Research and Development
Washington, DC 20593



86 1 24 031

DTIC FILE COPY

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

The contents of this report reflect the views of the Coast Guard Research and Development Center, which is responsible for the facts and accuracy of data presented. This report does not constitute a standard, specification, or regulation.



SAMUEL F. POWEL, III

Technical Director

U.S. Coast Guard Research and Development Center
Avery Point, Groton, Connecticut 06340



Technical Report Documentation Page

1. Report No. CG-D-33-85	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Fire Resistance Testing of Bulkhead and Deck Penetrations		5. Report Date October 1985	
		6. Performing Organization Code	
		8. Performing Organization Report No. CGRADC-5/85	
7. Author(s) David E. Beene, Jr. and Jack H. Howes		10. Work Unit No. (TRAIS)	
9. Performing Organization Name and Address United States Coast Guard Research and Development Center Avery Point Groton, Connecticut 06340		11. Contract or Grant No.	
		13. Type of Report and Period Covered	
12. Sponsoring Agency Name and Address Department of Transportation U.S. Coast Guard Office of Research and Development Washington, D.C. 20593		14. Sponsoring Agency Code	
15. Supplementary Notes Testing performed by Underwriters Laboratories in Chicago, Illinois, under joint technical direction of the U.S. Coast Guard Research and Development Center, Avery Point, Groton, CT, and the Canadian Coast Guard, Place deVille, Ottawa, Canada			
16. Abstract The U.S. Coast Guard and the Canadian Coast Guard conducted a joint test program to obtain data on the passage of flame, smoke, and heat through penetration items in Class A-0 and Class A-60 deck assemblies. This data is to be used in establishing performance criteria for penetrations submitted for U.S. Coast Guard approval. All testing was carried out by Underwriters Laboratories in accordance with UL 1479, Standard for Fire Tests of Through-Penetration Firestops. Underwriters Laboratories' 1-meter furnace was used for all fire tests. Twenty-one combinations of penetration items were tested in Class A-0 and Class A-60 firestop assemblies. Two samples of each penetration item were tested: one in a Class A-0 deck assembly and one in a Class A-60 deck assembly. The Class A-0 deck assembly was a 36-inch x 36-inch x 3/16-inch (91.4 cm x 91.4 cm x 0.5 cm) steel plate. The Class A-60 deck assembly consisted of a steel plate identical to that used in the Class A-0 assembly, but rockwool insulation was applied to the fire side of the steel plate and penetration item. Nineteen of the twenty-one penetration items passed the requirements for a Class A-0 fire rating while only fourteen of the twenty-one items passed the requirements for a Class A-60 fire rating. The test results identified combinations of construction techniques for piping, ducting, and electrical cable penetrations which could be used to meet Coast Guard requirements for piercing Class A-0 and Class A-60 decks and bulkheads. The test results also indicated that the penetration items which failed could be modified to pass the requirements for either a Class A-0 or Class A-60 fire rating.			
17. Key Words penetrations bulkhead deck		18. Distribution Statement This document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161	
19. Security Classif. (of this report) UNCLASSIFIED	20. SECURITY CLASSIF. (of this page) UNCLASSIFIED	21. No. of Pages	22. Price

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

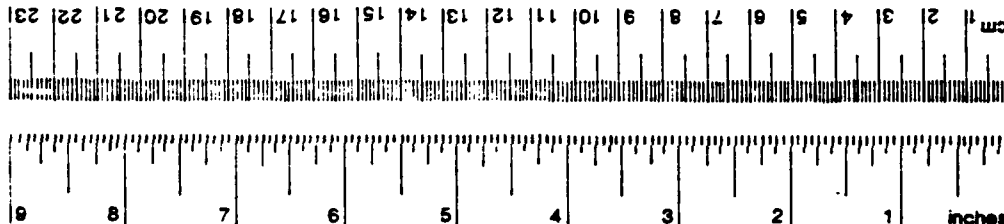
Symbol When You Know Multiply By To Find Symbol

		LENGTH		Symbol
		* 2.5	centimeters	
in	inches	30	cm	
ft	feet	0.9	m	
yd	yards	1.6	km	
mi	miles			
		AREA		Symbol
in ²	square inches	6.5	square centimeters	cm ²
ft ²	square feet	0.09	square meters	m ²
yd ²	square yards	0.8	square meters	m ²
mi ²	square miles	2.6	square kilometers	km ²
	acres	0.4	hectares	ha
		MASS (WEIGHT)		Symbol
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		Symbol
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft ³	cubic feet	0.03	cubic meters	m ³
yd ³	cubic yards	0.76	cubic meters	m ³

TEMPERATURE (EXACT)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C
----	------------------------	----------------------------	---------------------	----

* 1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures. Price \$2.25. SD Catalog No. C13.10.286



Approximate Conversions from Metric Measures

Symbol When You Know Multiply By To Find Symbol

		LENGTH		Symbol
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		Symbol
cm ²	square centimeters	0.16	square inches	in ²
m ²	square meters	1.2	square yards	yd ²
km ²	square kilometers	0.4	square miles	mi ²
ha	hectares (10,000 m ²)	2.5	acres	
		MASS (WEIGHT)		Symbol
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		Symbol
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	0.125	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m ³	cubic meters	35	cubic feet	ft ³
m ³	cubic meters	1.3	cubic yards	yd ³

TEMPERATURE (EXACT)

°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F
----	---------------------	-------------------	------------------------	----

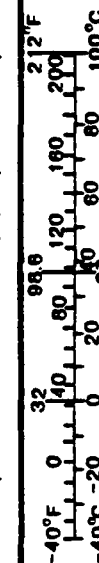


TABLE OF CONTENTS

	<u>Page</u>
1.0 OBJECTIVES	1
2.0 BACKGROUND	1
3.0 APPROACH	2
4.0 TEST METHOD	4
5.0 PROCEDURES	5
5.1 Test Assembly Construction	5
5.2 Fire Exposure Test	7
5.3 Hose Stream Test	7
6.0 RESULTS AND DISCUSSION	7
6.1 Class A-0 Penetrations	7
6.2 Class A-60 Penetrations	20
7.0 CONCLUSIONS	32
8.0 RECOMMENDATIONS	35
8.1 Penetration Designs	35
8.2 Future Testing	35
REFERENCES	36
APPENDIX A - Sample Penetrations	A-1
APPENDIX B - UL 1479, Standard for Fire Tests of Through- Penetration Firestops	B-1
APPENDIX C - UL Test Report	C-1

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1. Sample Penetrations	3
2. Class A-0 and Class A-60 Construction	6
3. Test Furnace	8
4. Test Pressure Differential	9
5. Class A-0 Test Failure	11
6. Temperatures on Steel Penetrant During Class A-0 Test	13
7. Temperatures on Copper Penetrant During Class A-0 Test	14
8. Temperatures on PVC Penetrant During Class A-0 Test	16
9. Temperatures on Ventilation Duct During Class A-0 Test	17

LIST OF FIGURES (con't)

<u>Figure</u>		<u>Page</u>
10.	Temperatures on Electrical Cable During Class A-0 Test	18
11.	Class A-60 Insulation	20
12.	Temperatures on Copper Pipe Failure (D4) During Class A-60 Test	21
13.	Temperatures on Copper Pipe Failure (D6) During Class A-60 Test	22
14.	Temperatures on Copper Pipe Failure (D8) During Class A-60 Test	23
15.	Temperatures on Copper Pipe Failure (D10) During Class A-60 Test	24
16.	Temperatures on Copper Pipe Failure (D12) During Class A-60 Test	25
17.	Temperatures on Ventilation Duct Failure (D17) During Class A-60 Test	26
18.	Temperatures on Electrical Cable Failure (D20) During Class A-60 Test	27
19.	Hose Stream Results	28
20.	Temperatures on Steel Penetrant During Class A-60 Test	29
21.	Temperatures on PVC Penetrant During Class A-60 Test	30
22.	Temperatures on Ventilation Duct During Class A-60 Test ...	31

LIST OF TABLES

<u>Table</u>		<u>Page</u>
1.	Penetration Test Results	10

1.0 OBJECTIVES

The purpose of this testing was to obtain data on the fire performance of bulkhead and deck penetrations used in shipboard construction. This data was collected for use in establishing acceptability criteria for individual penetrations submitted for future U.S. Coast Guard approval. A secondary objective was to provide guidelines of sample penetrations which successfully meet Coast Guard requirements for piercing Class A-0 and Class A-60 decks and bulkheads and which also followed good marine practice in design and construction.

2.0 BACKGROUND

Criteria included in 46 CFR of the Code of Federal Regulations, Subchapter Q, 164.007 (Reference 1), for fire resistance of bulkheads and decks have long been based on the widely-recognized ASTM Standard E119 test method. With the E119 method, the test fire barrier panel is incorporated into one face of a furnace. The test furnace is then fired, and the rate at which the temperature inside the furnace rises is controlled so that the standard time-temperature curve is closely followed. The E119 test measures the fire resistance of the test barrier as determined by the time elapsed before failure (i.e., when the passage of flame or smoke, or excessive heat transmission, is allowed through the barrier.)

In recent years, a number of investigators have compared the standard E119 curve with actual time-temperature curves recorded in test compartment fire experiments. The E119 curve is generally regarded as a more severe exposure than that observed in the usual types of compartment test fires, although some test fires have shown a more rapid initial temperature rise and/or a higher momentary peak temperature. The standard curve was developed decades ago, before the introduction of many current construction techniques and materials. Today there has been an even greater change in typical compartment fuel loading, much of which is due to the presence of large quantities of plastics and other synthetic materials. The present consensus is that while the standard curve exposure is still more severe than many actual fires, this gap is steadily decreasing.

Shipboard fire barrier bulkhead and deck materials may be highly resistant to fire, but if the numerous barrier penetrations necessary for piping, electrical cabling, and ventilation ducting are not equally resistant, barrier integrity can be seriously compromised. To avoid this, details of bulkhead and deck penetrations must be examined to ensure that they do not adversely affect the fire resistance provided by the barrier in which they are installed. Presently, bulkheads and decks aboard merchant vessels are designed to meet fire endurance requirements which are dependent upon their location within the vessel. Once they are installed, they are often breached to allow piping, wiring, or ventilation ducting to pass through. In order to maintain an effective fire boundary, these penetrations must be properly sealed to maintain a degree of fire endurance equivalent to the structural member they pierce. For example, a penetration through a Class A-0 deck or bulkhead must be capable of preventing the passage of flame and smoke for one hour (Reference 2). A penetration through a Class A-60 deck or bulkhead must

be capable of: (a) preventing the passage of flame and smoke for one hour, (b) preventing a temperature rise on the unexposed fire of more than 325°F (180°C) above ambient temperature at any one point, and (c) preventing an average temperature rise on the unexposed fire side of more than 250°F (139°C) above the ambient temperature (Reference 2).

While ASTM E119 has been used for many years as the basis for comparing fire resistance of basic barrier materials, similar standards dealing specifically with penetrations have appeared only recently, e.g., ASTM E814, UL 1479, and IEEE 634. Of these, UL 1479 and ASTM E814 appear to provide the most suitable test method to use in evaluating shipboard penetration fire performance. UL 1479 and ASTM E814 are similar in context and combine the features of ASTM E119 which deals only with basic barrier materials, and IEEE 634, which deals only with electrical penetrations.

UL 1479 and ASTM E814 use the same type of test furnace as E119 and include the same time-temperature control curve. Data collected during this test indicate the time elapsing before smoke or flame occurrence on the unexposed surface and the time elapsing before a limiting temperature rise. Provision is also made for a hose stream test to determine whether the penetration will develop an opening that would allow water to be sprayed through that barrier from the exposed side to beyond the unexposed side.

3.0 APPROACH

The types of penetrations investigated were:

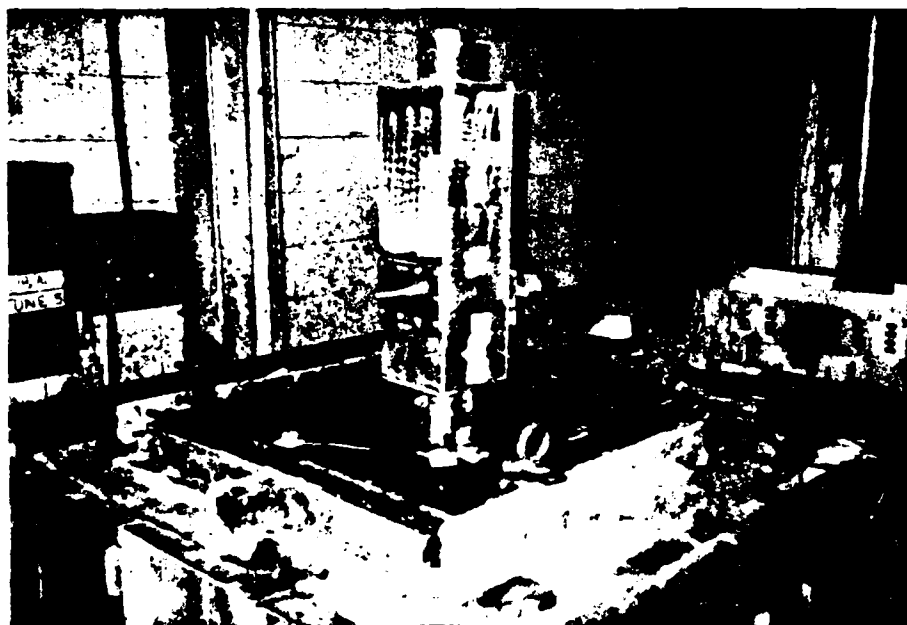
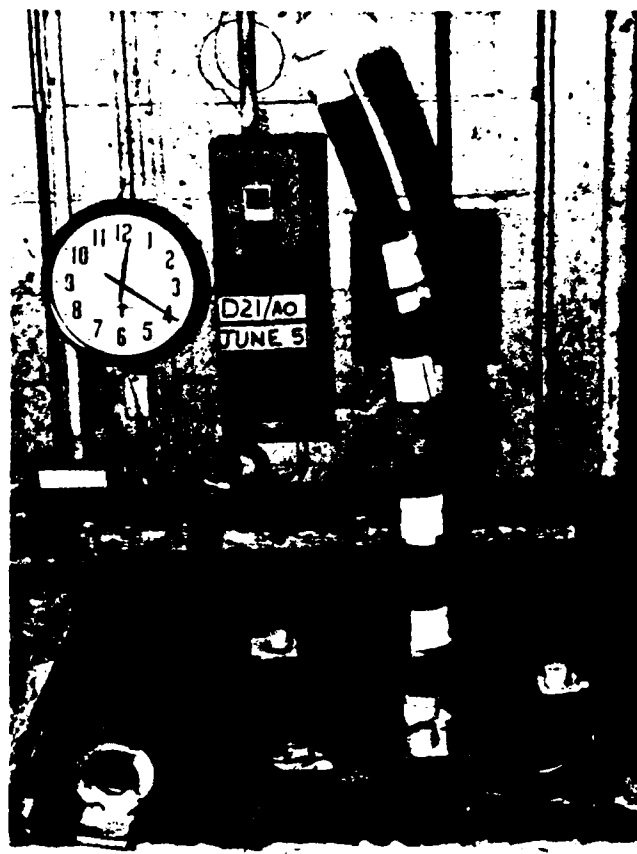
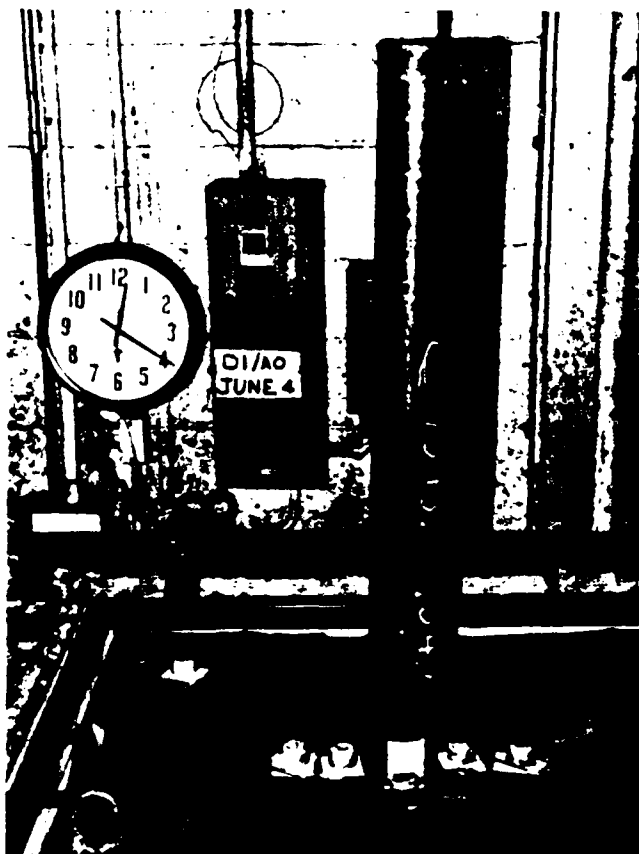
- Piping: steel, copper, plastic (PVC)
- Ventilation ducting: with/without damper
- Electrical Cabling: multiple, single cables

Figure 1 shows a sample of each type of penetration.

Test exposure was designed to determine whether the penetrations meet Class A-0 division requirements for passage of flame and smoke, and Class A-60 requirements for passage of flame, smoke, and heat transmission.

Individual penetrations were selected for testing from the following groups:

- Piping penetration details similar to those shown in U.S. Coast Guard Navigation and Vessel Inspection Circular No. 6-80 and Canadian Coast Guard standard sketches (References 2 and 3)
- Electrical cable penetration details similar either to designs already approved by the U.S. Coast Guard and listed in CG-293 or to designs shown in Canadian Coast Guard standard sketches. (Reference 4)



Top Left: Steel Pipe
Bottom Left: Ventilation Duct
Top Right: Electrical Cable

Accession For	
NTIS CRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

Figure 1. Sample Penetrations

- Ventilation duct penetration details similar to designs shown in Canadian Coast Guard standard sketches (Reference 3)

Primary interest was in penetrations for steel, nonferrous, and non-metallic pipe; single and multiple electrical cable runs; and ordinary ventilation ducting. A general description of each penetration tested is listed in Appendix A. A detailed drawing and technical description of each penetration assembly are located in the individual data sections of Appendix C. Testing involved penetrations intended for Class A-0 (no insulation) and Class A-60 (with insulation) bulkheads and decks; deck coverings were not included, since this would introduce a possible flammability problem for the testing laboratory if the covering or the adhesive on the unexposed surface of the furnace were to ignite. Only one sample of each selected penetration design was tested because of the high price of sample construction, testing cost, and the time required to test the many samples selected.

4.0 TEST METHOD

A recognized standard laboratory fire resistance test method was considered essential for lending credibility to test results. In addition, a testing furnace with a controlled time-temperature curve was deemed necessary to reduce possible variations in fire exposure and to provide more consistent results in fewer tests. A recognized test method and a controlled temperature curve provided great flexibility because tests could be conducted at a later date and the results compared. These criteria and credibility appeared evident in UL Standard 1479 (Reference 5) and in ASTM E814 (Reference 6). Underwriters Laboratories' 1-meter furnace was used for all tests because it was less expensive than their larger furnace, and the failure of one sample would not affect the results of adjacent panels in the larger furnace. In addition, the smaller furnace is more practical and less expensive as an ongoing compliance test when testing a limited number of samples. UL has verified that tests conducted in their one meter furnace produce results comparable to those produced in their larger furnaces.

Thus, the penetrations were subjected to UL 1479 (ASTM E814) tests in order to obtain data as to their acceptability for installation in Class A-0 and Class A-60 divisions. From these tests, the following data was obtained for each penetration item:

- Actual time-temperature curve to which the penetration was exposed during the test
- The time that flame was observed on the unexposed side
- The time that smoke was observed on the unexposed side
- The time-temperature history on the unexposed side
- Observations of significant details of the behavior of the penetration during the test, and a description of the condition of the penetration after the test

- A photographic record of the test arrangement and significant behavior during the test

Each test was continued for at least 60 minutes unless serious failure occurred earlier.

5.0 PROCEDURES

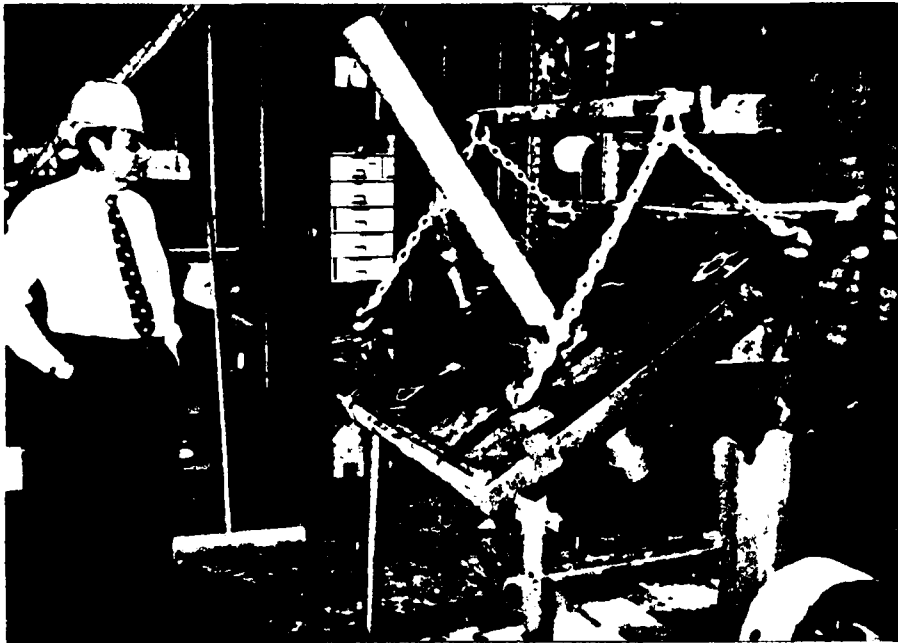
All tests were conducted in accordance with UL 1479 Standard for Fire Tests Through-Penetration Firestops (ASTM E814). The standard includes fire exposure, heat transmission, and hose (water) stream testing. A copy of the standard is attached as Appendix B.

Forty-two penetration samples were tested. There were two samples for each of the twenty-one different penetration items. Each of the twenty-one penetrations consisted of three steel piping items, nine copper piping items, four PVC piping items, two ventilation duct items, and three electrical cable items. Each of the forty-two penetration samples was installed in a Class A-0 deck assembly. One-half of the penetration samples were then insulated with rockwool batts to form a Class A-60 assembly (Figure 2).

Between nine and twenty-eight temperature readings were recorded inside the furnace and on the non-exposed side of the penetrant and deck assemblies. Thermocouple locations were specified in UL 1479. Measurements and observations were made for the development of through openings or flaming on the unexposed surface, acceptable limits of thermal transmission, and the passage of water during the hose stream test. Pressure conditions within the furnace and of the water stream were also recorded. A 35mm camera was used to maintain photographic records of the tests. A videotape recording of the overall test procedure was also made. Test data as recorded by UL is listed in Appendix C.

5.1 Test Assembly Construction

The U.S. Coast Guard and the Canadian Coast Guard selected and designed the penetrating items and firestop systems. The items consisted of standard construction materials and represented standard firestop systems used in penetrating shipboard Class A-0 and Class A-60 decks and bulkheads. The penetrating items included various combinations of steel pipes, copper pipes, PVC pipes, ventilation ducts, and electrical cables. The firestop systems included steel plate, bronze plate, and proprietary fire resistant sealant and devices. The samples were manufactured by Davie Shipbuilding Limited in Quebec, Canada. They were delivered to Underwriters Laboratories in Chicago, Illinois, with each penetration item in a 36-inch x 36-inch x 3/16-inch (91.4 cm x 91.4 cm x 0.5 cm) thick steel plate. All sample construction was representative of Class A-0 construction. The UL staff secured insulation (rockwool batts) to the fire side of the steel plates and penetrating items to prepare Class A-60 deck assemblies. The rockwool batts complied with the Class A-60 structural insulation requirements of 46 CFR 164.007 (Reference 1). The attachment of the batts to the penetrations and assemblies is described in Appendix C.



Class A-0



Class A-60

Figure 2. Class A-0 and Class A-60 Construction

5.2 Fire Exposure Test

The penetration assemblies were tested in accordance with the requirements of UL 1479. The tests were conducted on the horizontal furnace shown in Figure 3. The furnace has a 31.5-inch x 31.5-inch (80 cm x 80 cm) opening. A detail drawing of the furnace is presented in Appendix C. Furnace temperatures were regulated to follow the standard time-temperature curve in UL 1479. Type K chromel alumel thermocouples were used for all temperature measurements. The thermocouple locations for each sample are listed in Appendix C.

An electronic barometer was used during the fire tests to measure the pressure differential between the furnace and the laboratory. The pressure differential was measured and recorded for six tests. The furnace operation for these six tests was identical to the furnace operation of all forty-two tests. The pressure differential was 0.002 mm Hg (0.28Pa) negative at the beginning of each test, but was gradually increased to a maximum positive pressure differential of 0.025 mm Hg (3.33Pa) by the end of each 60-minute test (Figure 4).

5.3 Hose Stream Test

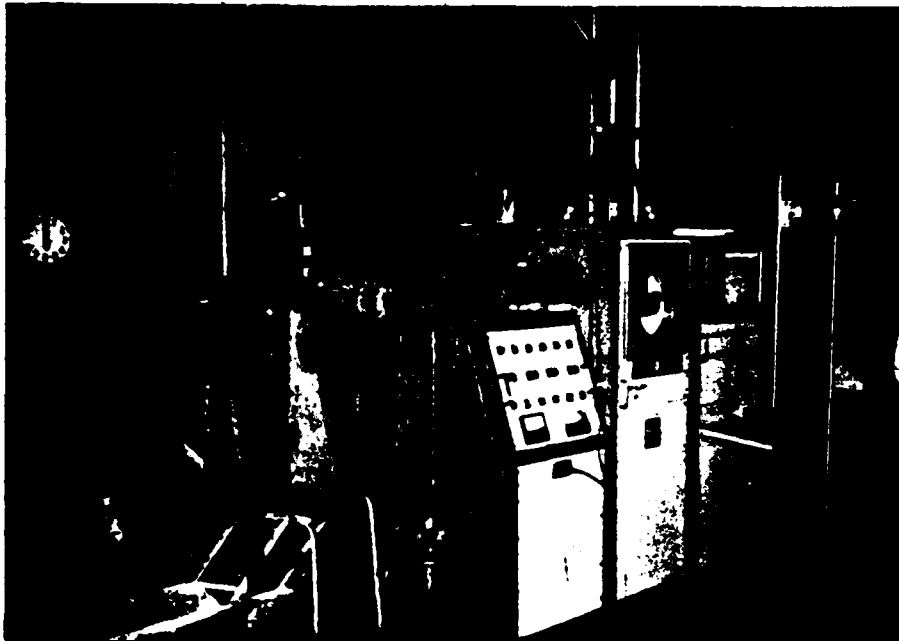
A hose stream test was conducted on forty penetration items. Immediately following the 1-hour fire exposure, the sample was removed from the furnace. It was placed in a steel support rack and pivoted vertically 90 degrees to represent a wall assembly. Water from a hose was applied to the exposed surface of the deck assembly approximately four minutes after the furnace fire was extinguished. This consisted of a 30-psi water stream applied at a perpendicular distance of 20 feet (6.1 m) from the center of the test assembly. The water stream was applied to the deck assembly and penetrating item for 13.5 seconds.

6.0 RESULTS AND DISCUSSION

The results of these tests are shown in Table 1; the principal characteristics of the penetration types are described in Sections 6.1 and 6.2. For all discussions in this report, "spigot" will refer to a length of pipe which either replaces or encloses a continuous run of pipe, duct, or electrical cable.

6.1 Class A-0 Penetrations

Only penetration samples D14 and D19 failed the Class A-0 exposure test. Twenty-five minutes into the test the PVC penetration (D14) was issuing heavy amounts of smoke on the unexposed side of the penetration assembly. At twenty-eight minutes it ignited and began to burn, Figure 5. Forty-four minutes into the test, the penetrant had collapsed and the test was terminated. Because the penetrant had collapsed during the fire test, the hose stream test was not conducted. Fifteen minutes into the test the multiple electrical cable penetration (D19) was issuing heavy smoke from the base of the cable jackets on the unexposed surface. By thirty-one minutes



Furnace Controls and Data Recording Equipment



Penetration Sample Being Tested in Furnace

Figure 3. Test Furnace

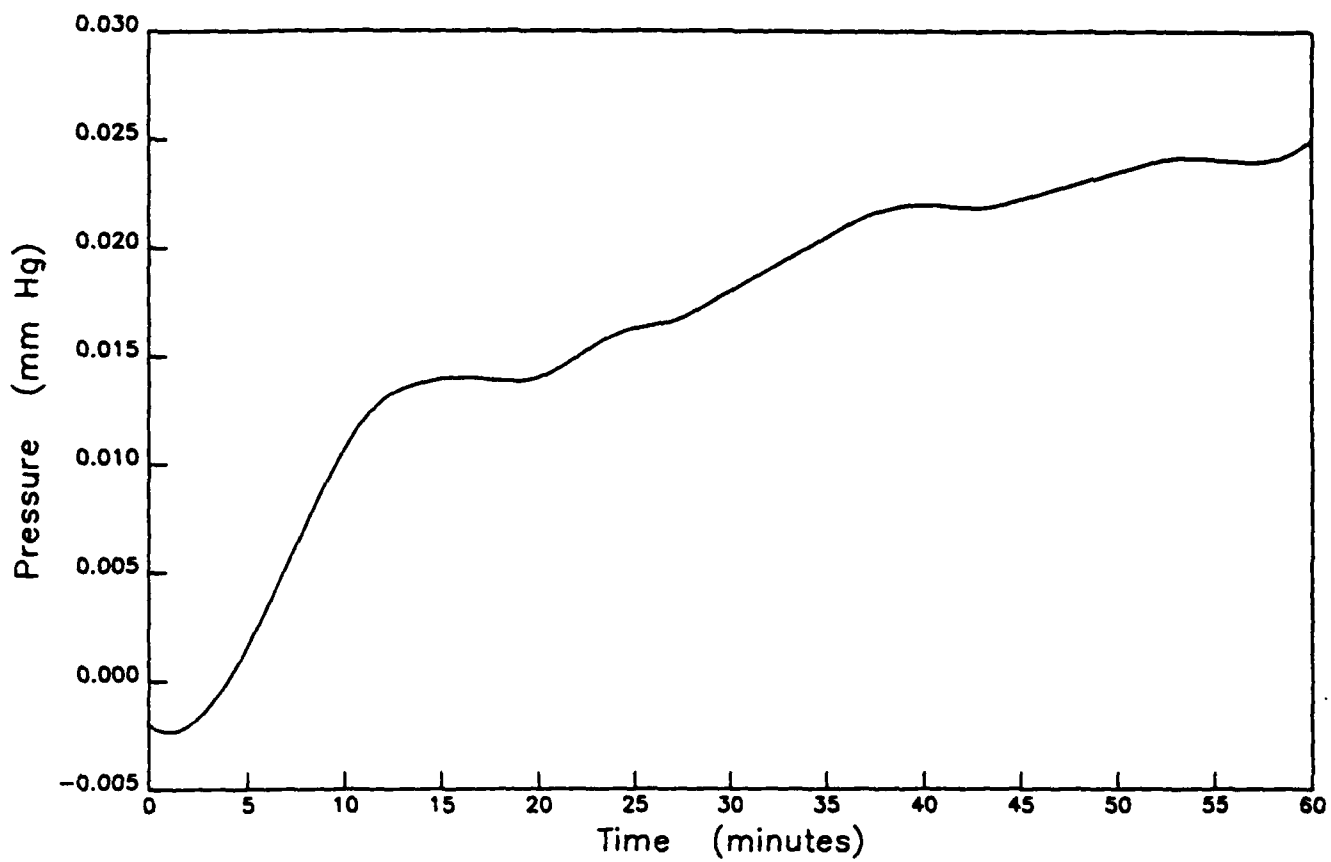


Figure 4. Test Pressure Differential

TABLE 1
PENETRATION TEST RESULTS

CLASS A-0 SAMPLES				CLASS A-60 SAMPLES			
Observations on Unexposed Side				Observations on Unexposed Side			
Sample Number	Flame (Minutes)	Smoke (Minutes)	Hose Stream Test (Water)	Flame (Minutes)	Smoke (Minutes)	Temperature Rise of 325°F (180°C) (Minutes)	Hose Stream Test (Water)
D1	> 60	> 60	None	> 60	> 60	> 60	None
D2	> 60	> 60	None	> 60	> 60	> 60	None
D3	> 60	> 60	None	> 60	> 60	> 60	None
D4	> 60	> 60	None	> 60	> 60	48*	None
D5	> 60	> 60	None	> 60	> 60	> 60	None
D6	> 60	> 60	None	> 60	> 60	44*	None
D7	> 60	> 60	None	> 60	> 60	> 60	None
D8	> 60	> 60	None	> 60	> 60	44*	Not tested
D9	> 60	> 60	None	> 60	> 60	> 60	Not tested
D10	> 60	> 60	None	> 60	> 60	48*	None
D11	> 60	> 60	None	> 60	> 60	> 60	None
D12	> 60	> 60	None	> 60	> 60	40*	None
D13	> 60	> 60	None	> 60	> 60	> 60	None
D14	28*	25*	Not tested	> 60	> 60	> 60	None
D15	> 60	> 60	None	> 60	> 60	> 60	None
D16	> 60	> 60	None	> 60	> 60	> 60	None
D17	> 60	> 60	None	> 60	> 60	36*	None
D18	> 60	> 60	None	> 60	> 60	> 60	None
D19	31*	15*	None	> 60	> 60	> 60	None
D20	> 60	> 60	None	> 60	> 60	> 60	None
D21	> 60	> 60	None	> 60	> 60	> 60	None

* Failure



Sample D14/AO

Figure 5. Class A-O Test Failure

the cables had ignited at the base of the assembly on the unexposed side and at thirty-two minutes the furnace test was terminated. A hose stream test was conducted since the electrical cables did not collapse.

Observations recorded for penetration samples D14 and D19 during the Class A-0 exposure tests do not indicate that an opening occurred which permitted the passage of smoke and flame through the samples. However, smoke and flame were observed on the nonexposed side of the penetration assemblies. This is a failure according to Coast Guard regulations for Class A-0.

Three combinations of steel pipe penetrations (D1, D2, D3) were tested. None failed the Class A-0 test. These penetrations included a long steel pipe, a long steel spigot with copper piping, and a short steel spigot with copper piping. The average of the highest temperatures at a 1-inch (2.5 cm) height on the steel spigots was 1140°F (616°C), while the average of the highest temperature at a 24-inch (61 cm) height was 2740°F (1340°C). Figure 6 shows representative temperature plots recorded at heights of 1, 6, 12, 18, and 24 inches (2.5, 15, 30, 46, and 61 cm) on a steel penetrant. In sample D2/A-0, the brazing melted and failed to hold a 3-inch (7.6 cm) section of copper tube brazed to a bronze flange. The penetration, however, did not fail the fire exposure test, even though the inside of the steel piping was exposed to the full heat of the furnace.

Nine combinations of copper piping penetrations were tested. These penetration samples included:

- Long and short copper spigots (D4, D5, D6)
- Copper piping through long and short spigots with fire resistant sealant packed in between the pipes (D7, D8)
- Copper piping through long and short steel spigots with terminal tubes (D9, D10)
- Copper piping passing through long and short steel spigots attached by brazing (D11, D12)

None failed the Class A-0 test. Figure 7 shows typical temperature plots recorded at five heights on the copper penetrations. The average of the highest temperatures recorded at a 1-inch (2.5 cm) height on the copper penetrants was 1088°F (587°C). The average of the highest temperature recorded at a 24-inch (61 cm) height on the copper penetrations was 4120°F (2110°C). None of the different copper piping combinations deviated significantly from the average temperature recorded at five similar heights on all the copper penetrations. Copper penetration temperatures were close in value to the steel penetrants at a 1-inch (2.5 cm) height on the penetrants but also were almost double the steel's temperature values at a 24-inch (61 cm) height. Penetrations D7, D8, D11, and D12 showed the highest temperature deviation from the average temperatures recorded on the penetrants

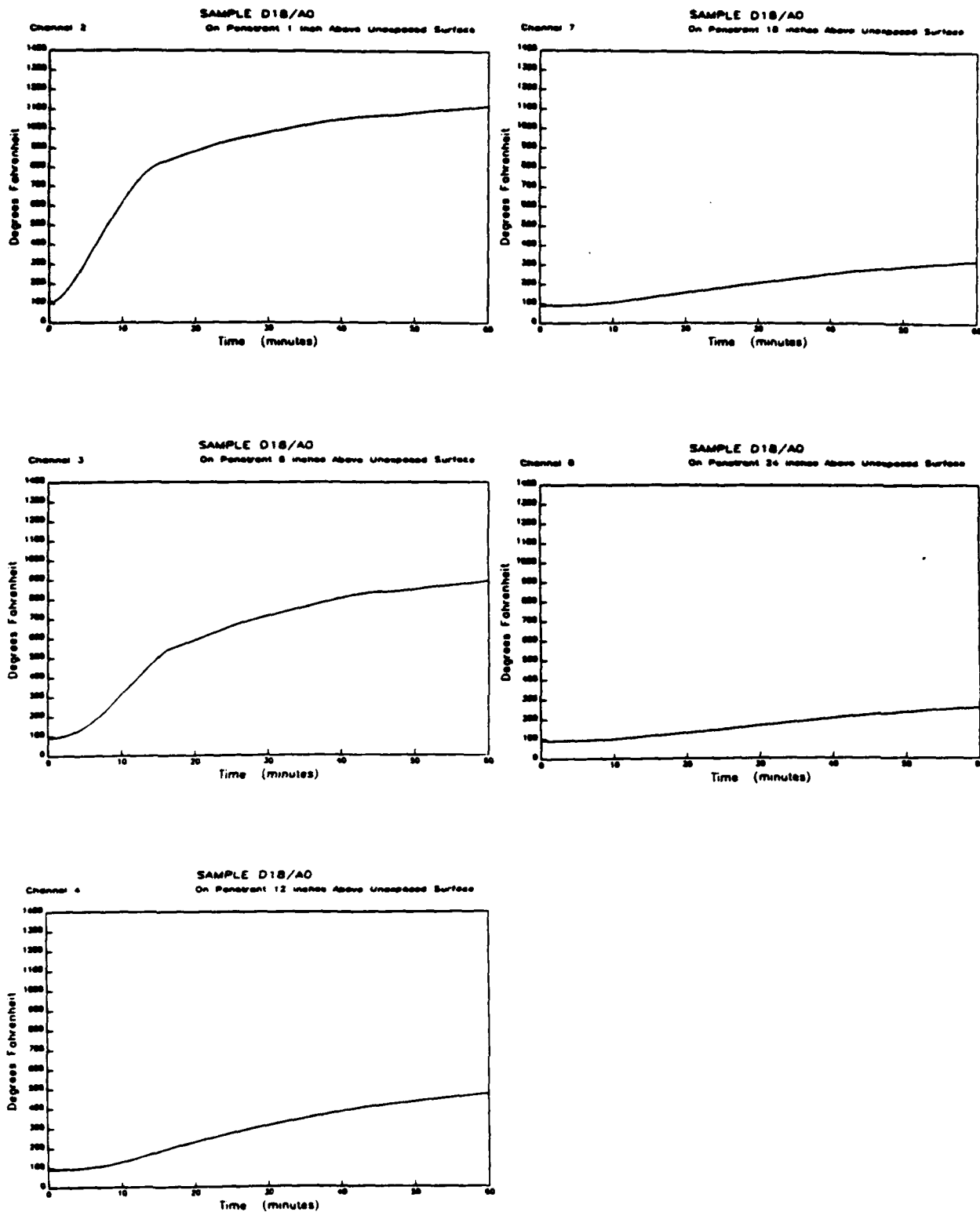


Figure 6. Temperatures on Steel Penetrant
During Class A-0 Test

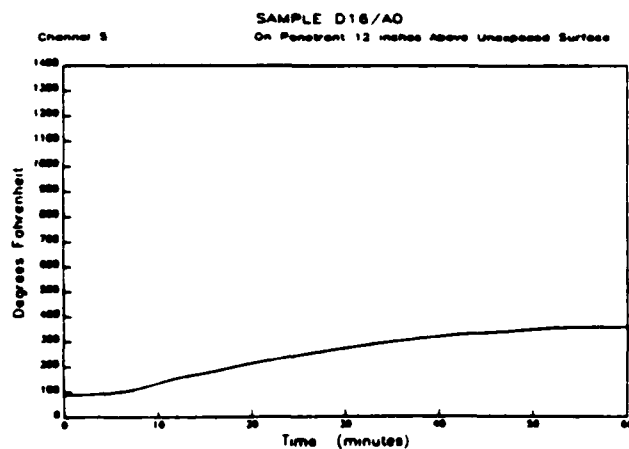
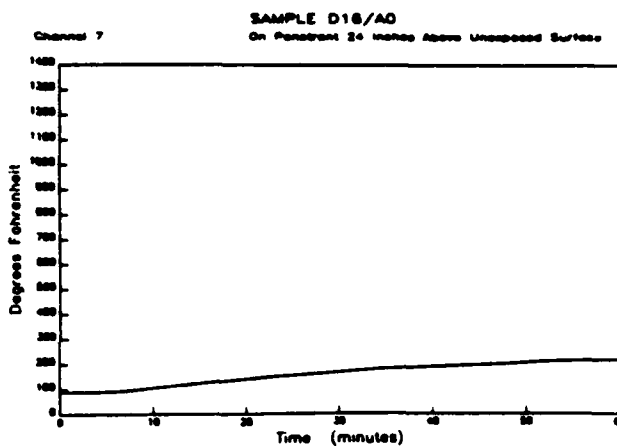
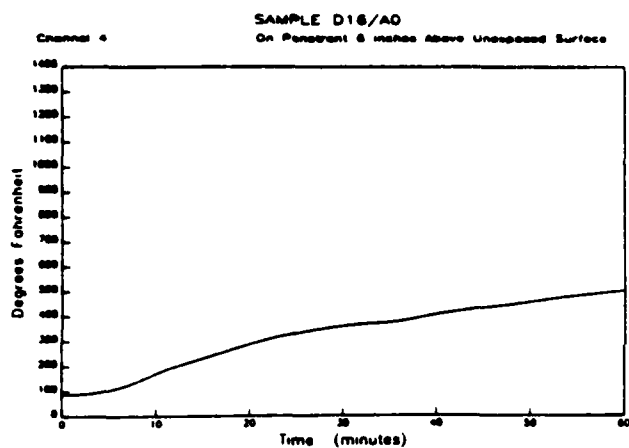
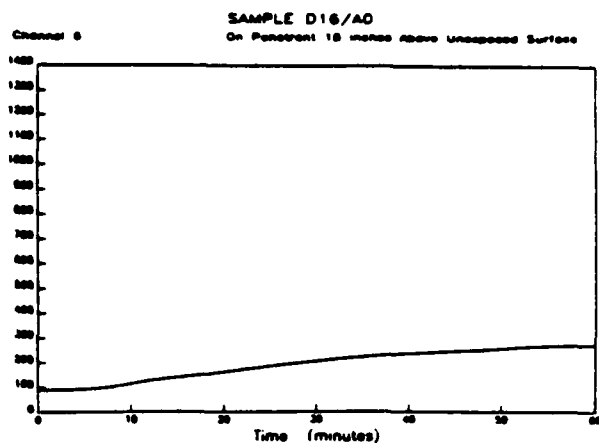
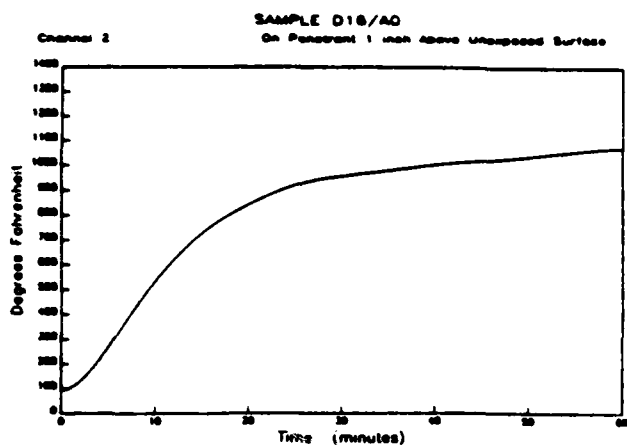


Figure 7. Temperatures on Copper Penetrant During Class A-0 Test

at a 24-inch (61 cm) height. These penetrations consisted of similar construction materials and pipe lengths with no flanges. The other copper penetrations (D4, D5, D6, D9, and D10) had flanges or terminal tubes which acted as thermal sinks against prevention of heat transmission through the penetration piping.

Four PVC penetrations (D13, D14, D15, and D16) were tested. Two penetrations consisted of PVC piping which was flanged or threaded by terminal tubes to steel spigots. The remaining two penetrations consisted of PVC pipes passing through either long or short steel spigots, with fire retardant sealant packed between the different pipes. The average of the highest temperatures recorded at the 1-inch (2.5 cm) height on the PVC penetration assemblies was 1095°F (591°C). The average of the highest temperatures recorded at a 24 inch (61 cm) height on the PVC penetrants was 230°F (110°C). The plots in Figure 8 show five temperature readings taken on a PVC penetrant. The temperatures recorded at a 1-inch (2.5 cm) height were comparable to those recorded at similar locations on the steel and copper penetrant. The temperatures at a 24-inch (61 cm) height were lower than those recorded for the steel and copper penetrants. Only one PVC penetrant (D14) failed the Class A-0 test because it allowed the passage of both flame and smoke.

Two types of ventilation penetrations (D17 and D18) were tested. Both penetrants passed the fire exposure and the hose stream tests. These penetrants consisted of a ventilation duct attached to a long steel spigot and a ventilation duct with a fire damper attached to a short steel spigot. The average of the high temperatures recorded at a 1-inch (2.5 cm) height on the ventilation ducts was 1110°F (599°C). The average of the high temperatures recorded at a 24-inch (61 cm) height on the ducts was 445°F (229°C). No significant changes occurred in the penetrants during the fire tests. Figure 9 shows typical temperatures recorded at five heights on a ventilation duct on its unexposed fire side. The temperatures at a 1-inch (2.5 cm) height are equal to those of steel and copper penetrations.

One multiple electrical cable penetration (D19) and two single electrical cable penetrations (D20 and D21) were tested. Of the three electrical cable penetrations, only the multiple electrical cable penetration failed the fire exposure test. The hose stream did not penetrate the burned cables. Figure 10 shows typical temperature plots at four heights on an electrical cable penetration. The overall temperature at a 24-inch (61 cm) height was slightly lower than the temperatures at similar heights on the steel, copper, or ventilation penetrations.

The single electrical cables extending through steel spigots passed both the fire exposure test and hose stream test. The average of the highest temperatures recorded at a 1-inch (2.5 cm) height on the two single electric penetrants was 957°F (514°C). The average of the highest temperatures for the same two penetrants at a 24-inch (61 cm) height from the unexposed surface was 320°F (160°C). No significant changes occurred in the two samples during the fire test.

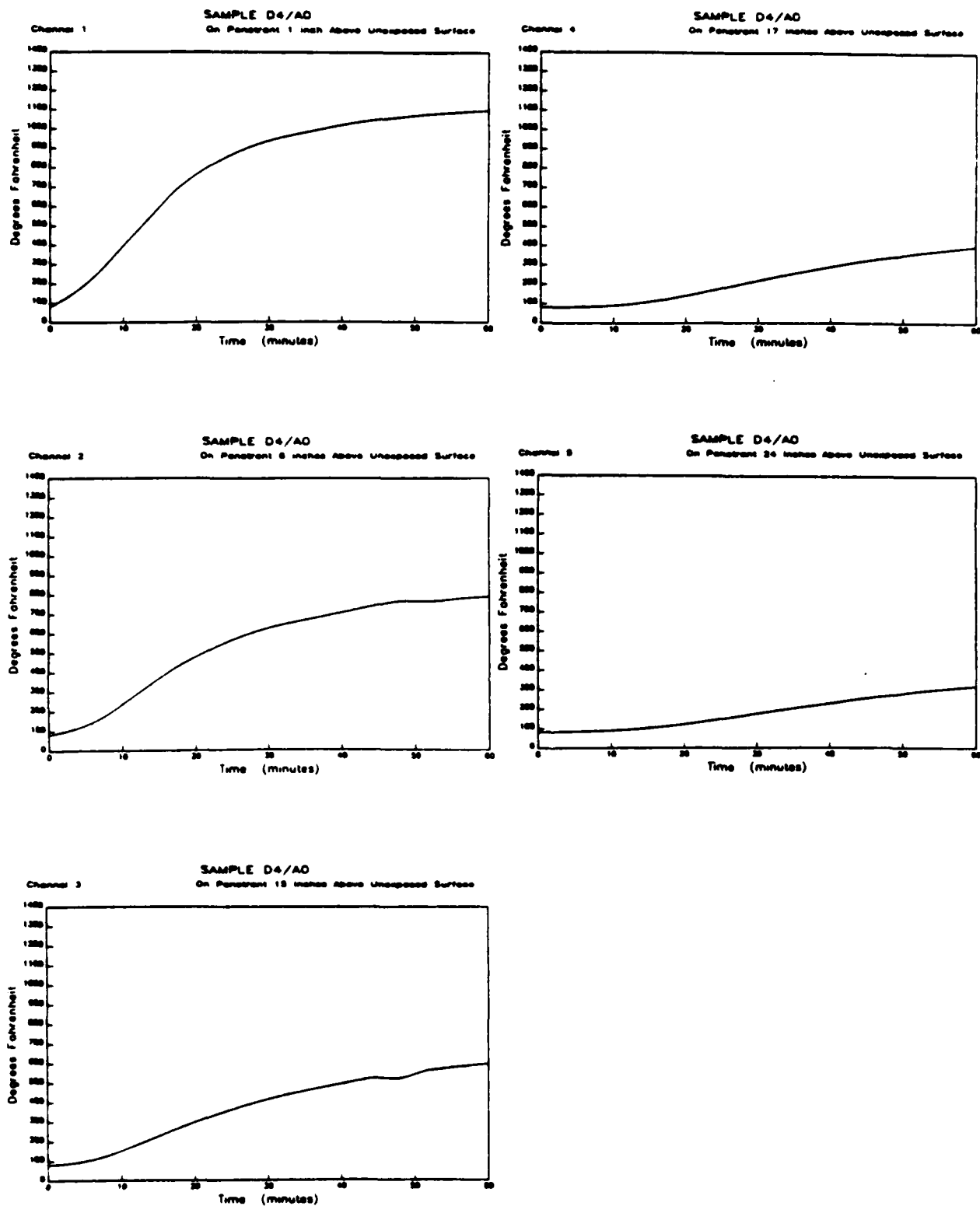


Figure 8. Temperatures on PVC Penetrant During Class A-0 Test

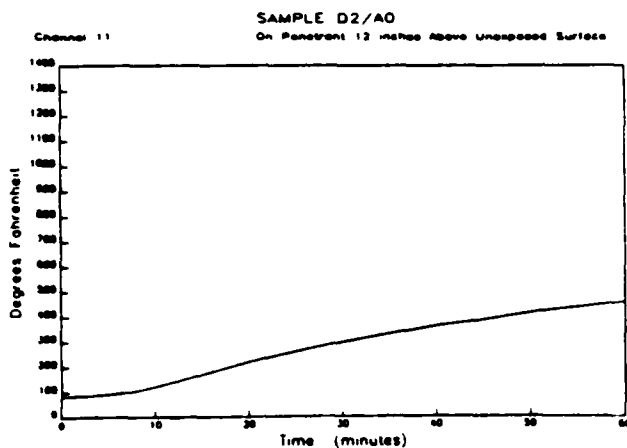
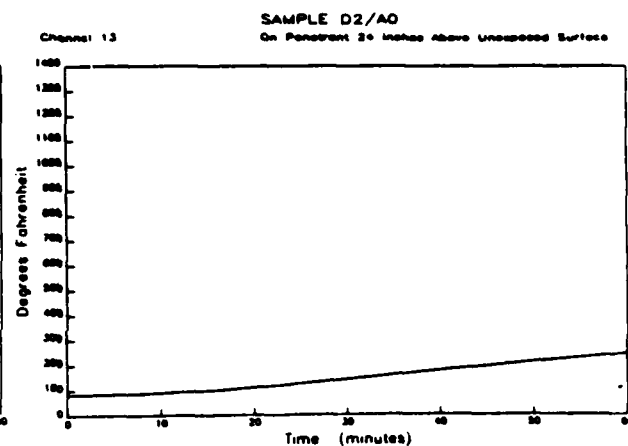
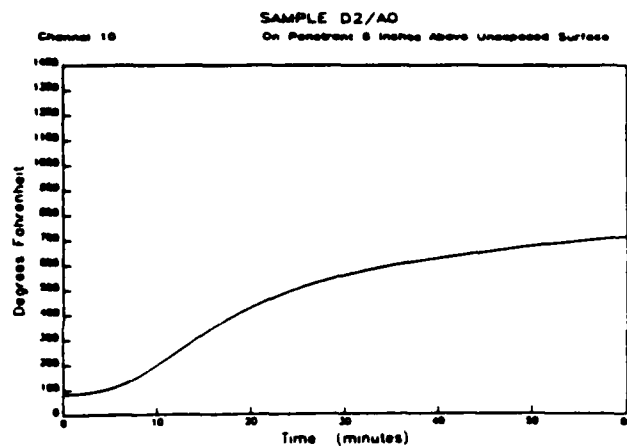
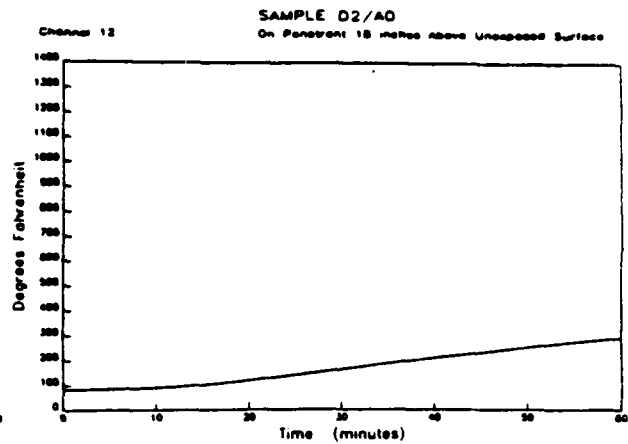
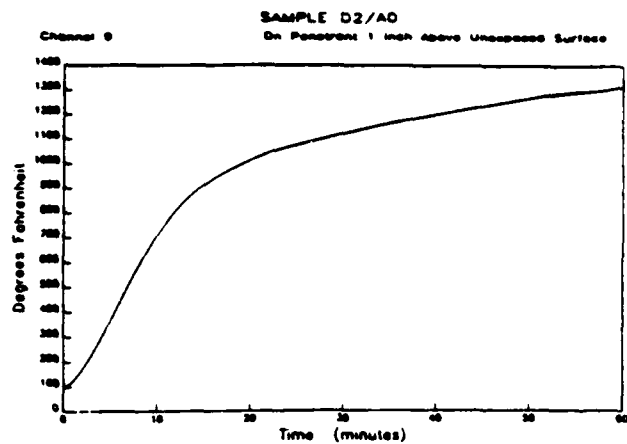


Figure 9. Temperatures on Ventilation Duct
During Class A-0 Test

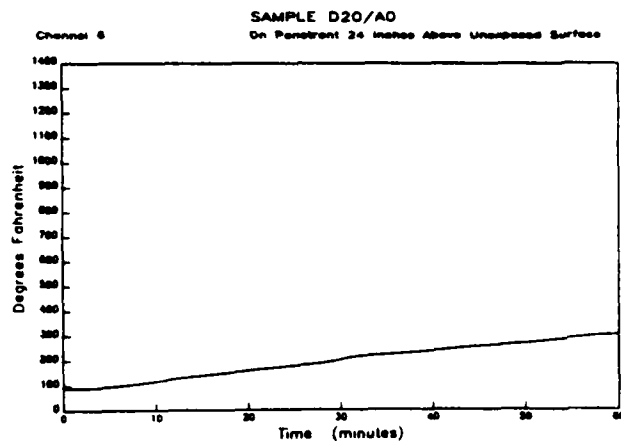
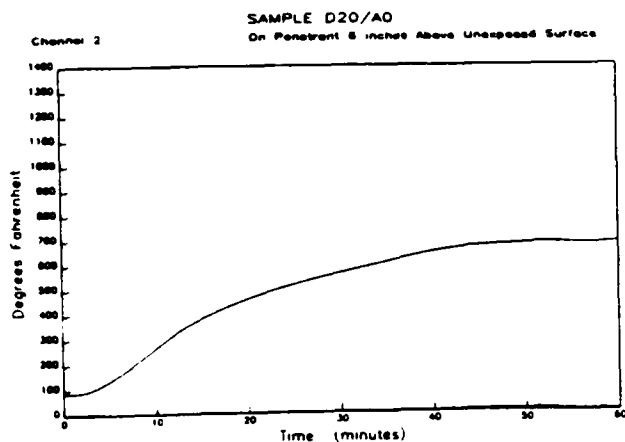
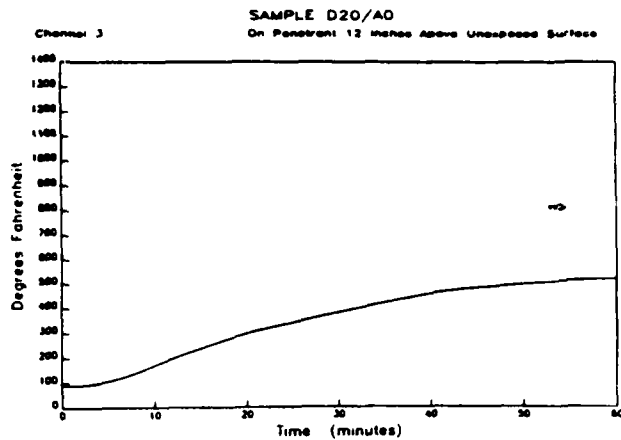
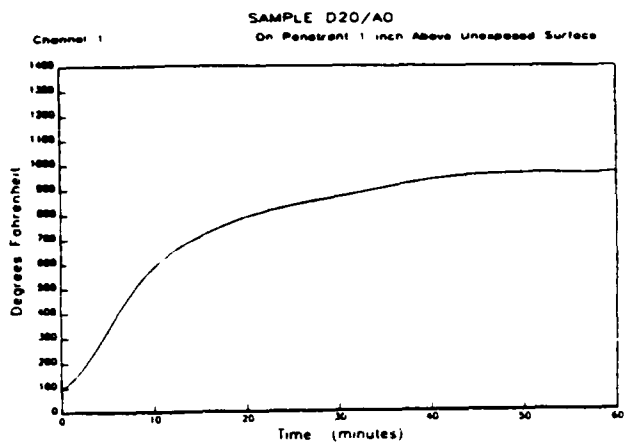


Figure 10. Temperatures on Electrical Cable
During Class A-0 Test

6.2 Class A-60 Penetrations

Only penetrations D4, D6, D8, D10, D12, D17, and D20 failed the heat transmission test for the insulated samples. Temperatures on these penetrants or test assemblies were recorded above acceptable limits. Figure 11 shows two insulated penetrations. The ambient temperature inside the area where the penetrations were stored was measured at 80°F (27°C). Figures 12 through 18 reflect temperature plots for the penetrations which failed the heat transmission test. Figure 19 shows the hose stream test and an insulated penetration after the hose stream test.

Three steel penetrations were evaluated in Class A-60 fire tests. All three passed the fire exposure, heat transmission, and hose stream tests. Figure 20 shows the temperature recorded at five heights on a typical Class A-60 steel penetration. These temperatures are well within the acceptable limits for the heat transmission test. The steel piping and insulation were an effective combination for a Class A-60 penetration assembly.

Nine copper penetrations were tested. All of them passed the fire exposure test, but five of the penetrations (D4, D6, D8, D10, and D12) failed the heat transmission test. The heat transmission through these penetrating items or their assemblies was above the acceptable limit for a Class A-60 rating. The plots in Figures 13 through 16 show the temperatures at different locations on these penetrants or assemblies which exceed the acceptable heat transmission limits.

Four PVC penetrations (D13, D14, D15, D16) were tested. The uninsulated PVC inside the furnace melted, but temperatures recorded on the non-fire side indicated that the PVC penetrations passed the fire exposure test and heat transmission tests. Temperatures recorded on all four insulated PVC penetrants closely parallel the temperature plots in Figure 21. It is interesting to note that the temperatures measured at a 1-inch (2.5 cm) height on the PVC penetrants are in the 200-to-300°F (93-to-149°C) range while the copper penetrants at the same height ranged from 300 to 500°F (149-to-260°C).

Two types of ventilation duct penetrations (D17, D18) were tested. Both ventilation ducts were on the unexposed fire side and were attached to a steel spigot which penetrated the test panel. One of the ducts (D18) contained a fire damper. Figure 22 shows fire temperature plots recorded on ventilation sample D18. This penetrant passed the Class A-60 requirements, while the temperature plot of the second ventilation sample (Figure 17) shows that it failed the heat transmission test. The data in Appendix C also shows that at the 24-inch (61 cm) height, penetration sample D17 had temperature three times as high as sample D18. An error by the sample manufacturer resulted in different structural dimensions for the two samples used in penetration D18. The Class A-0 sample had a 4 1/2-inch (11.4 cm) outer diameter steel spigot with a 8-inch by 8-inch (20.3 cm x 20.3 cm) fire damper while the Class A-60 sample had a 6-inch (15.2 cm) outer diameter steel spigot and a 10-inch by 10-inch (25.4 cm x 25.4 cm) fire damper.

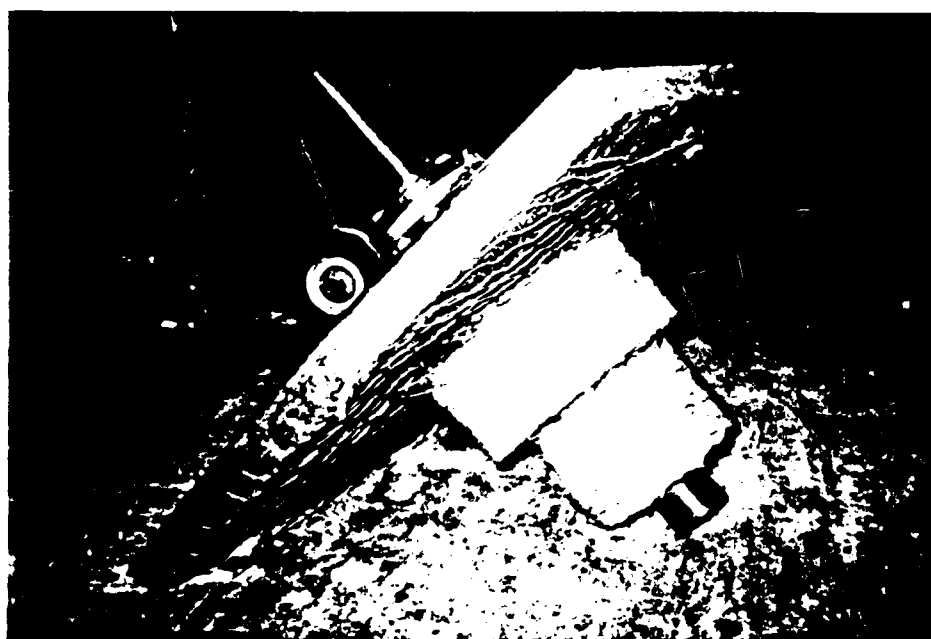


Figure 11. Class A-60 Insulation

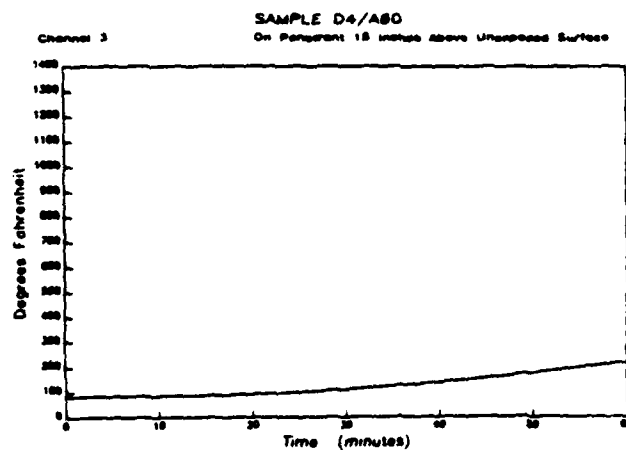
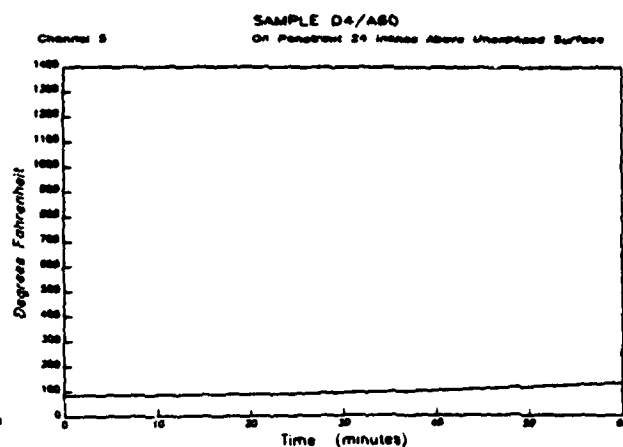
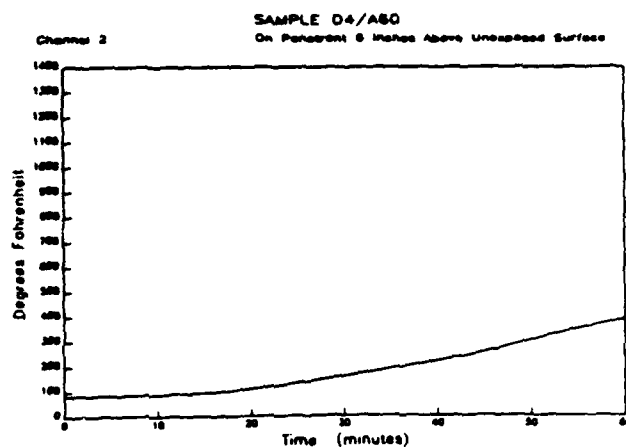
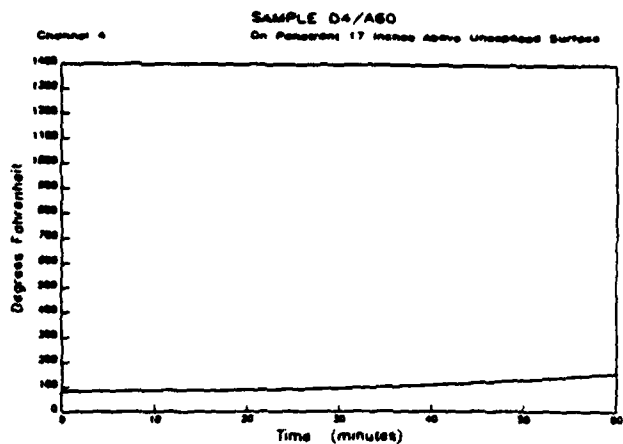
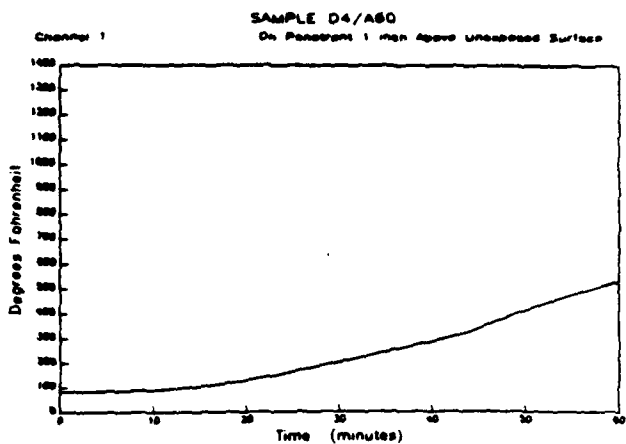


Figure 12. Temperatures on Copper Pipe Failure (D4) During Class A-60 Test

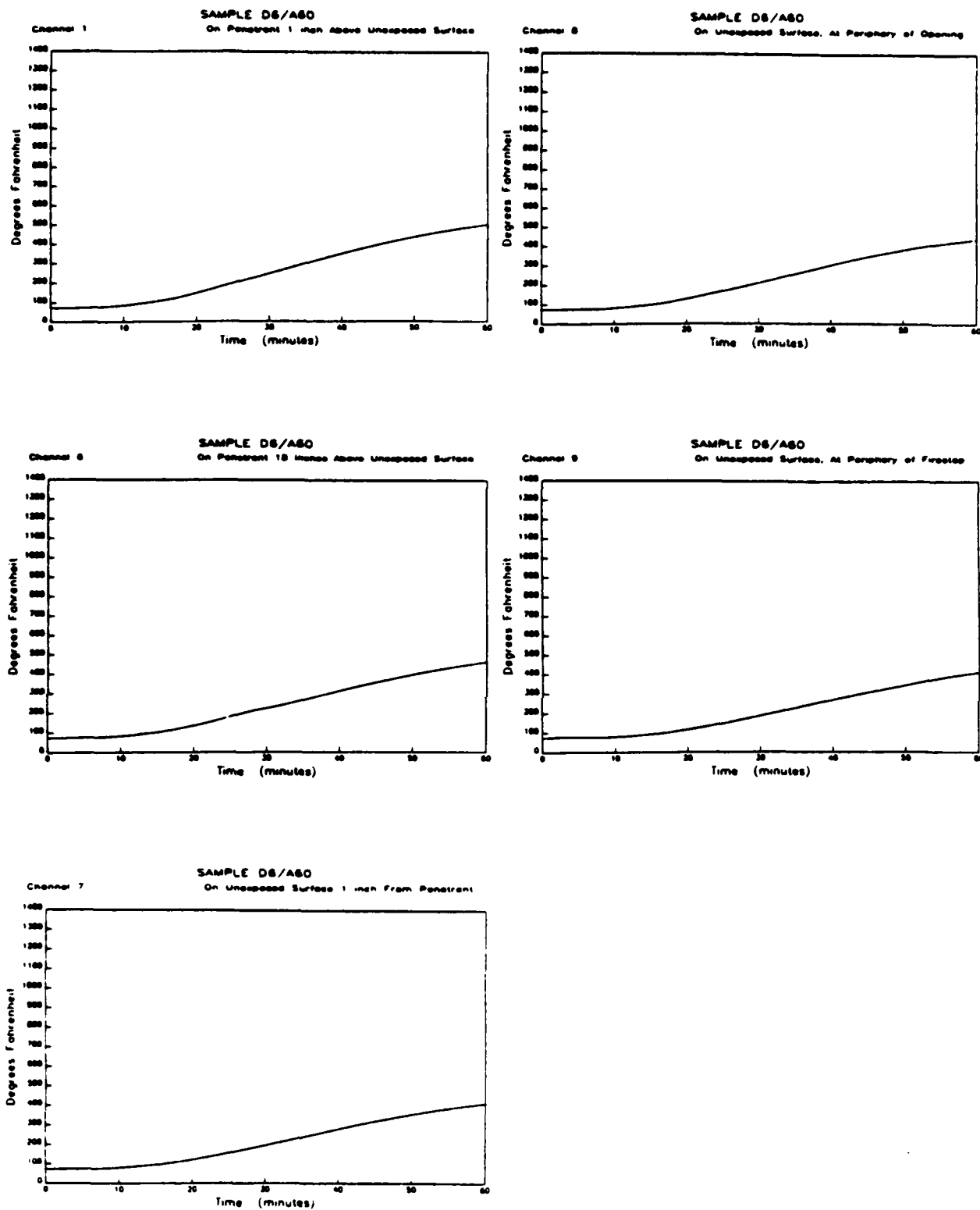


Figure 13. Temperatures on Copper Pipe Failure (D6) During Class A-60 Test

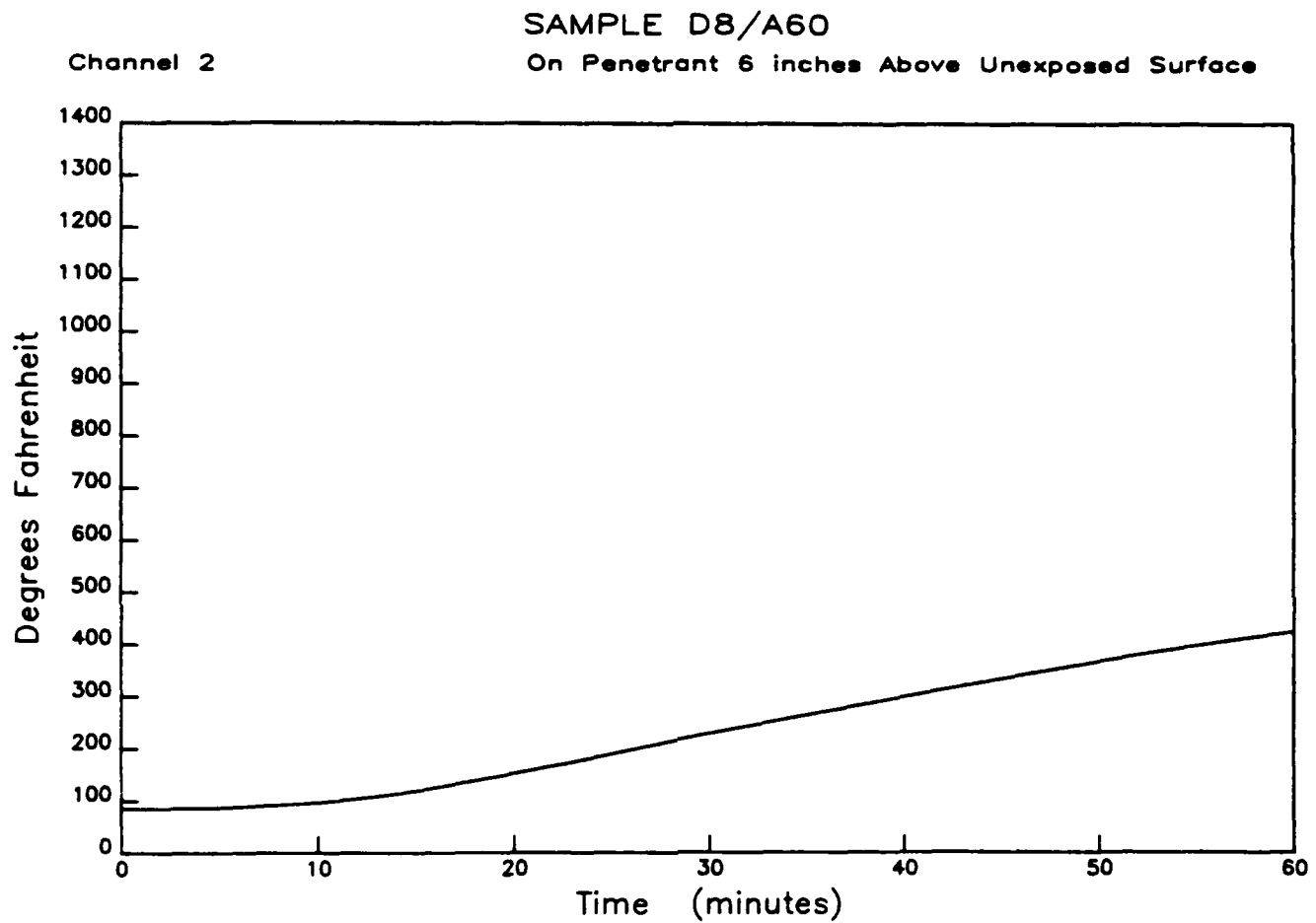


Figure 14. Temperatures on Copper Pipe Failure (D8) During Class A-60 Test

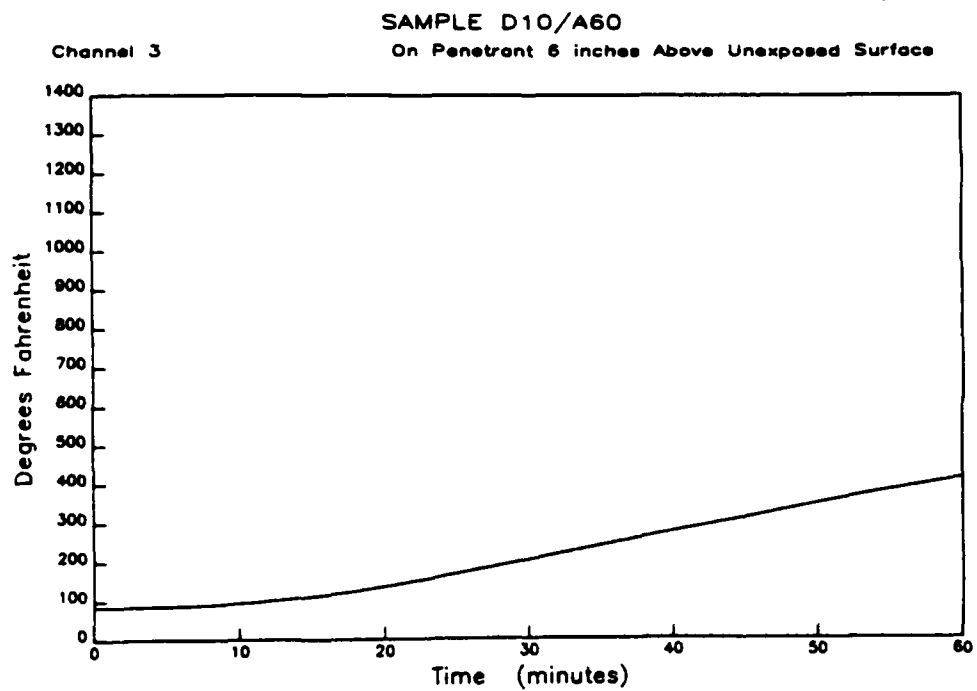
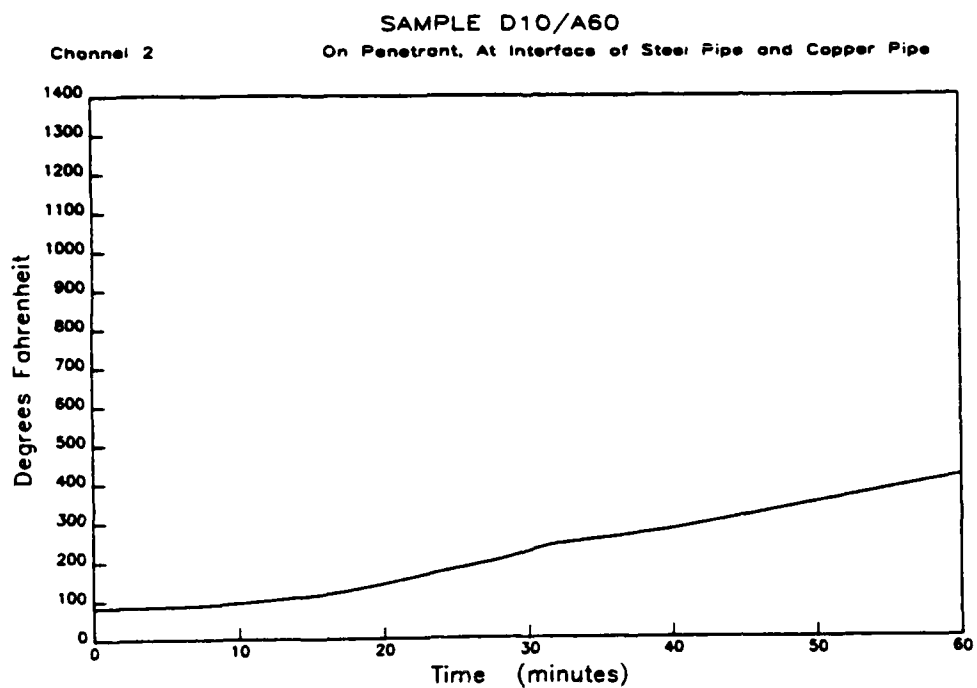


Figure 15. Temperatures on Copper Pipe Failure (D10) During Class A-60 Test

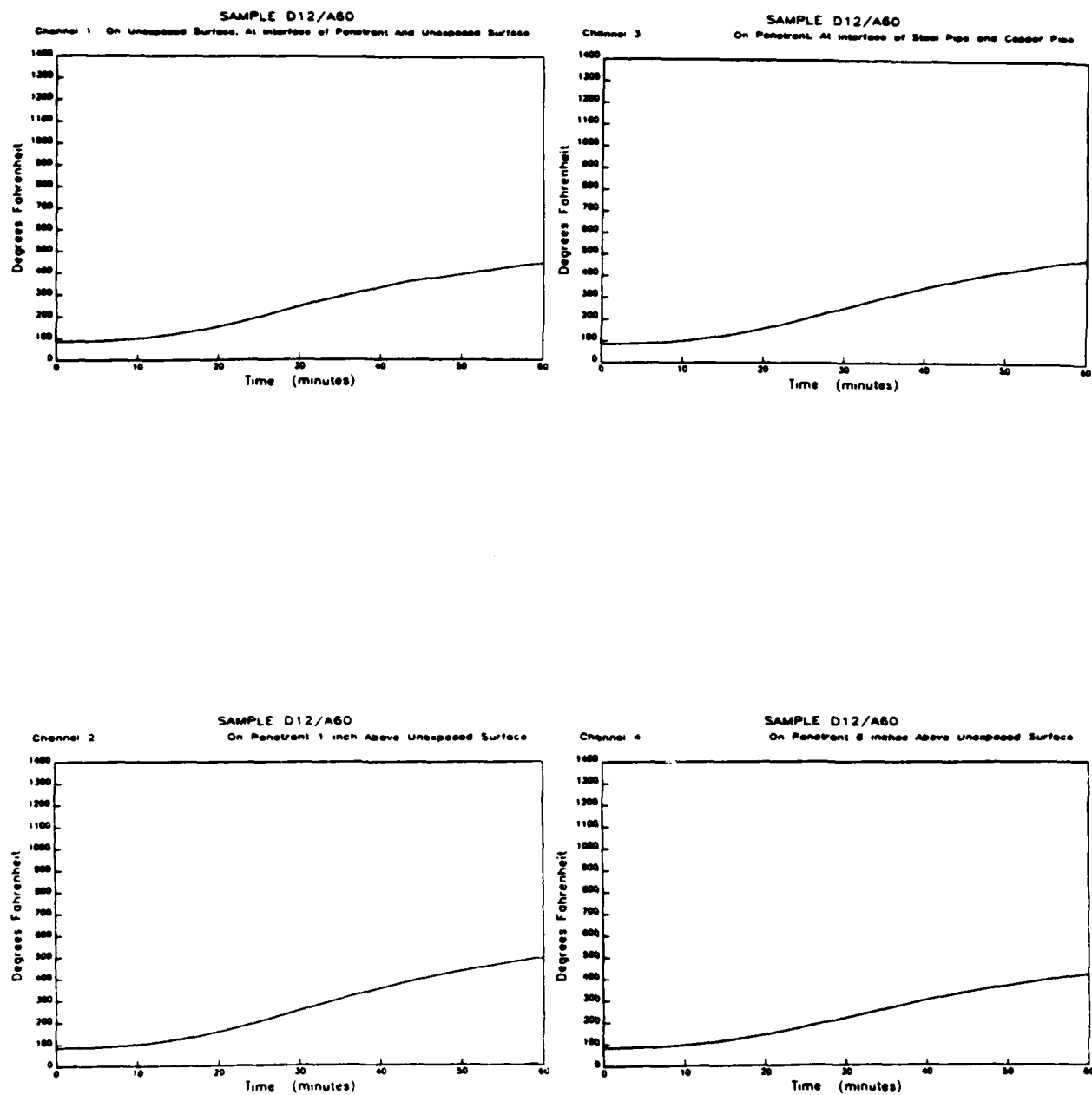


Figure 16. Temperatures on Copper Pipe Failure (D12) During Class A-60 Test

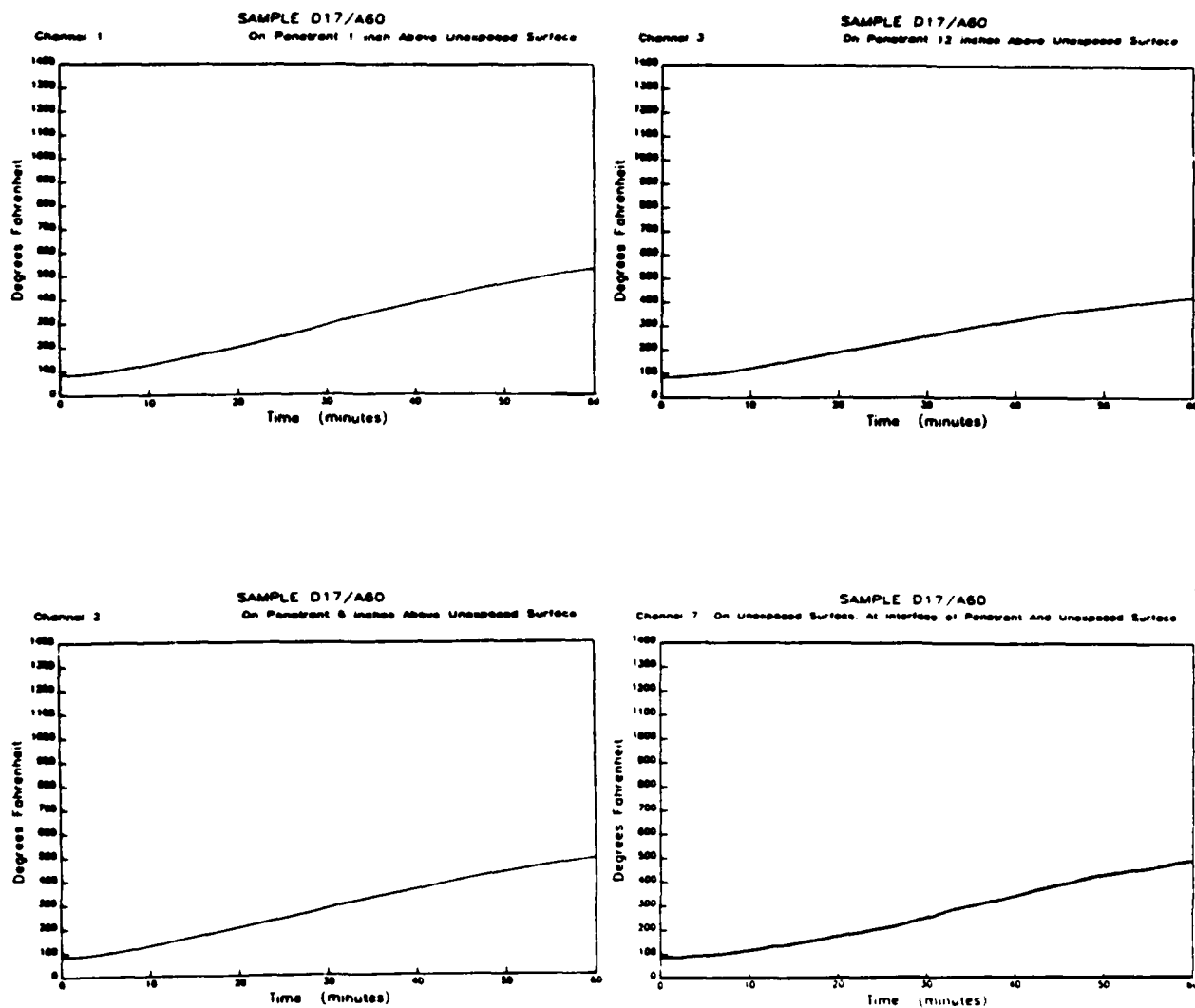


Figure 17. Temperatures on Ventilation Duct Failure (D17) During Class A-60 Test

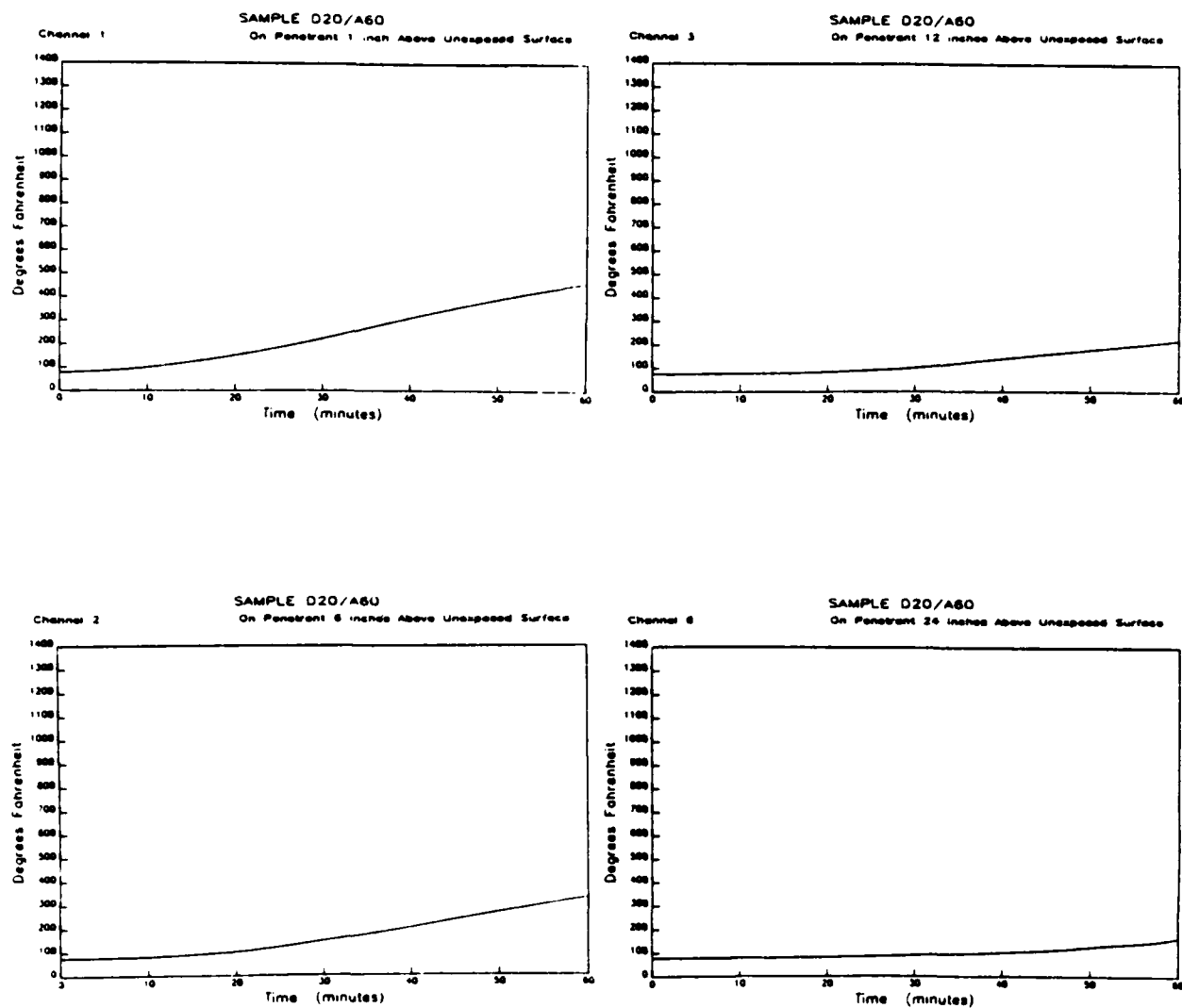


Figure 18. Temperatures on Electrical Cable Failure (D20) During Class A-60 Test



Hose Stream Test



Insulation After Hose Stream

Figure 19. Hose Stream Results

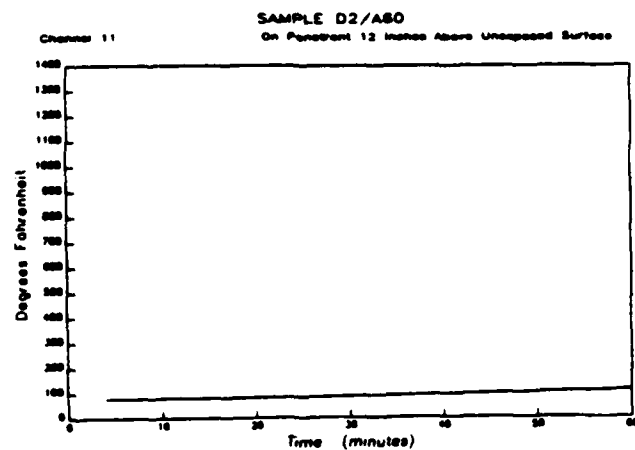
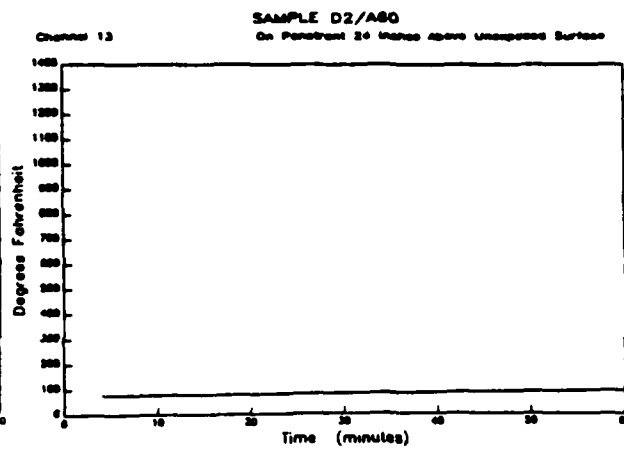
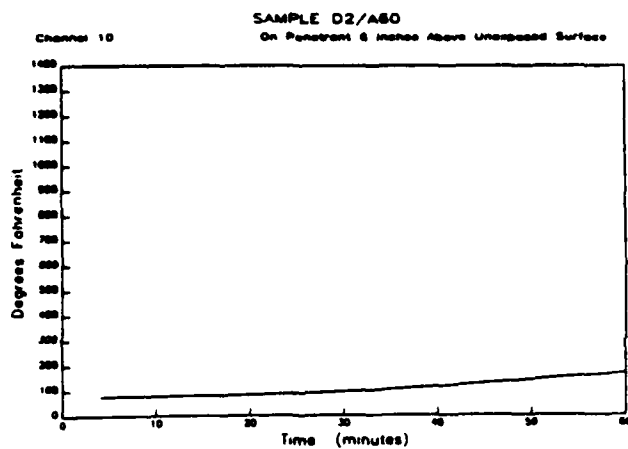
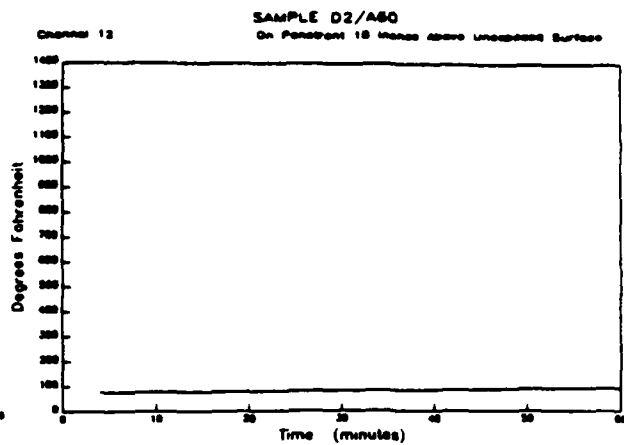
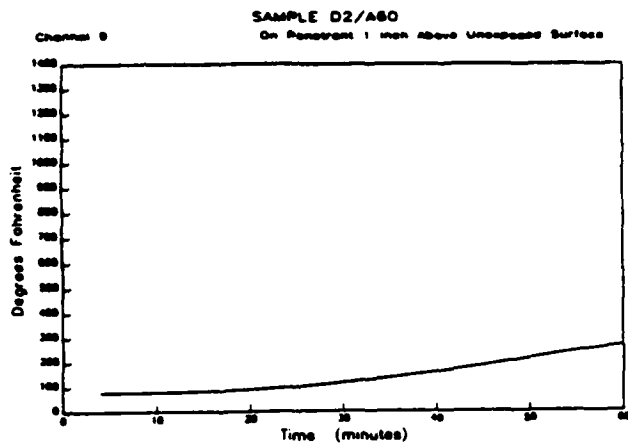


Figure 20. Temperatures on Steel Penetrant
During Class A-60 Test

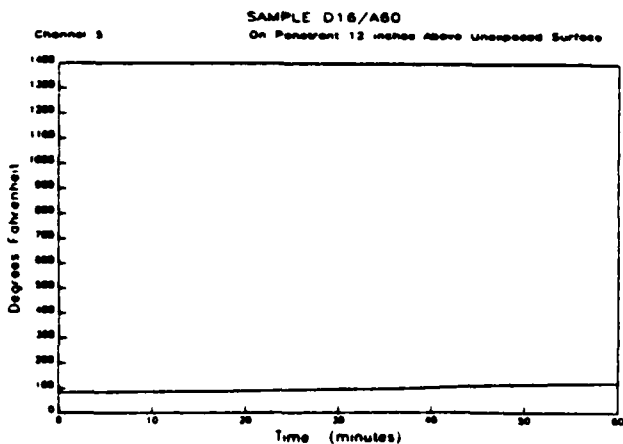
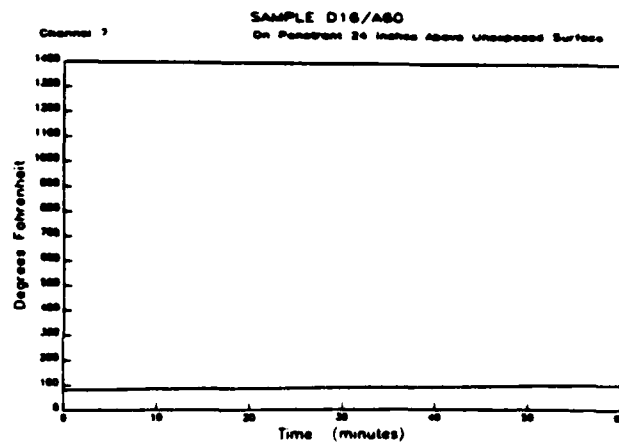
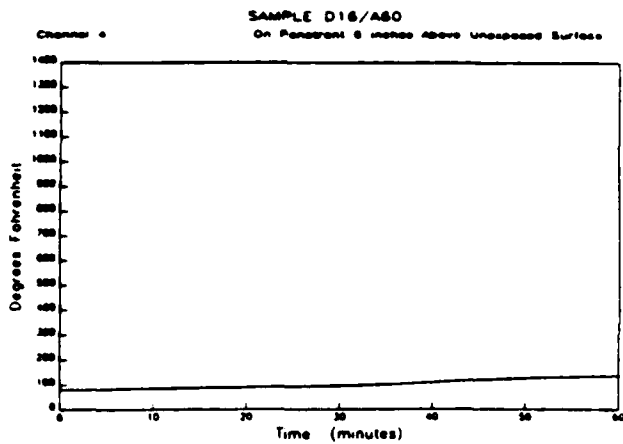
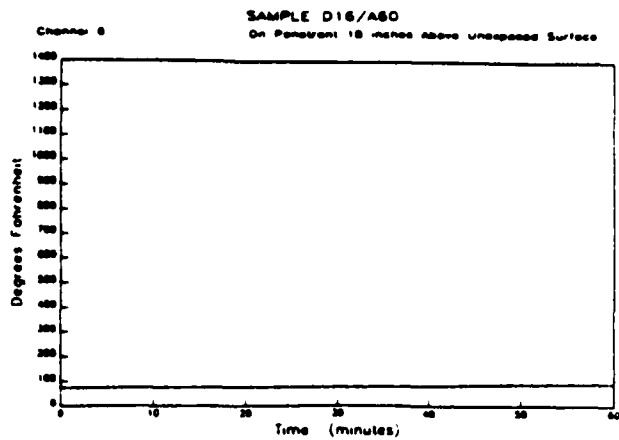
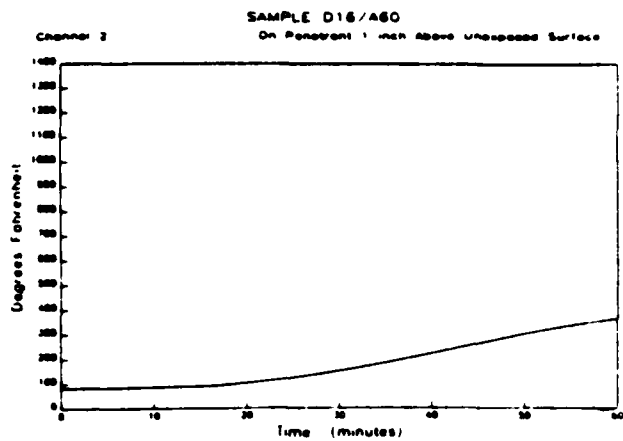


Figure 21. Temperatures on PVC Penetrant
During Class A-60 Test

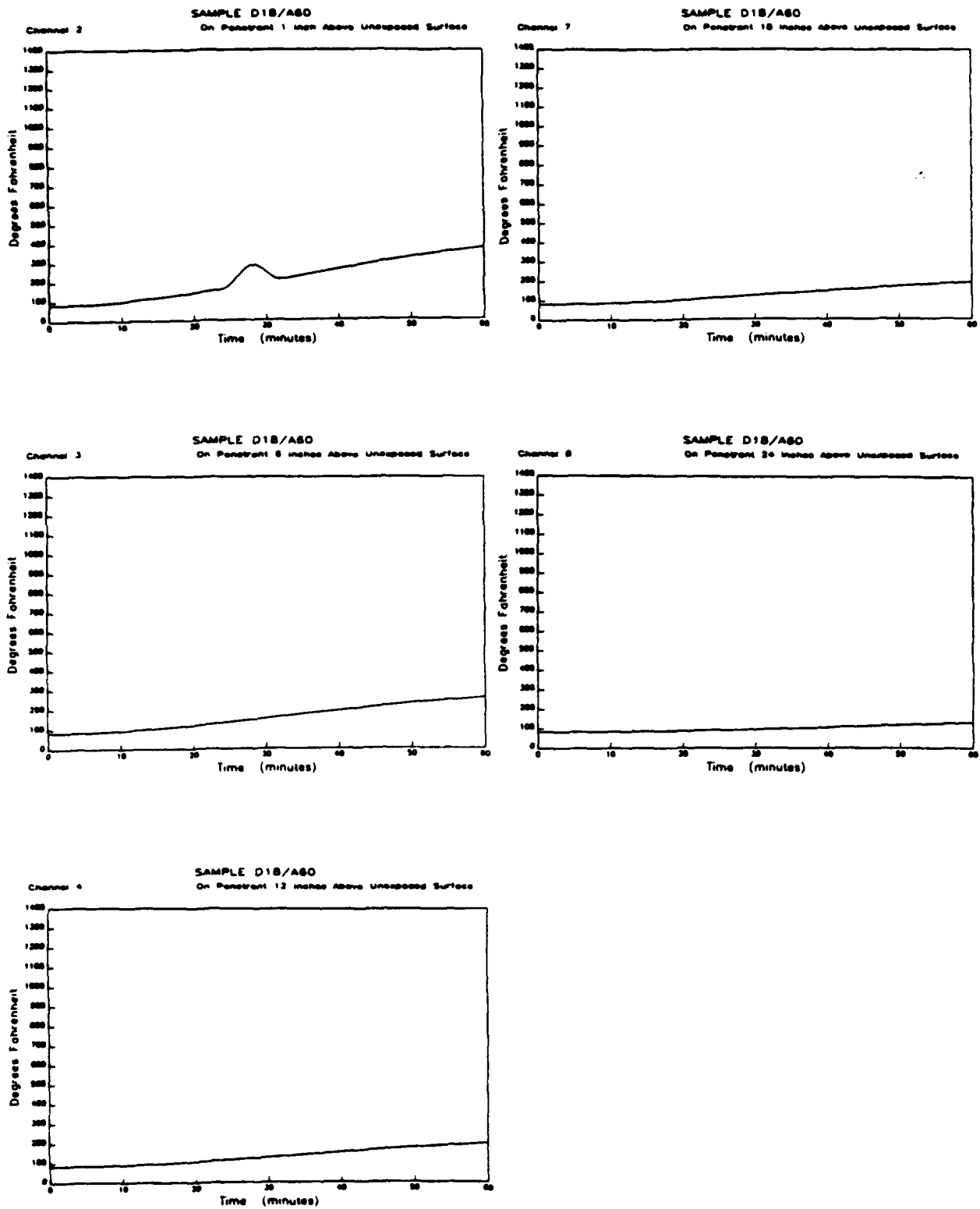


Figure 22. Temperatures on Ventilation Duct
During Class A-60 Test

One multiple electric cable assembly and two single electric cable penetrations (D19, D20, D21) were insulated and tested. One of the single electrical cable penetrants was insulated differently. In this case, only the test plate was insulated on the fire side, while the penetrant was insulated on the non-fire side. The penetrant which was insulated on the fire side passed the fire test and the heat transmission test. The penetrant insulated on the non-fire side passed the fire test but failed the heat transmission test. The two single electric cable penetrants were identical with the exception of the insulation. This evidence indicates that the insulation should be located on the fire exposed side of a deck or bulkhead if heat transmission is to be kept within the limits for a Class A-60 rating. The four temperature plots in Figure 18 show that the heat transmission for a Class A-60 rating is exceeded when the insulation is positioned around the penetrant on the non-fire side of the assembly.

7.0 CONCLUSIONS

Penetration D1 - A continuous seamless steel pipe with a steel collar plate continuously welded all around will provide a Class A-0 fire rating. It will also provide a Class A-60 fire rating when approved structural insulation extends 15 inches (38.1 cm) down the penetrant on the exposed fire side.

Penetration D2 - A flanged steel spigot with 15-inch (38.1 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel plate will provide a Class A-0 fire rating for a bronze flanged copper pipe. Fifteen inches (38.1 cm) of approved structural insulation extending down the penetrant's fire side will provide a Class A-60 fire rating.

Penetration D3 - A flanged steel spigot with 5-1/2 inch (14 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel plate will provide a Class A-0 fire rating for a bronze flanged copper pipe. It will also provide a Class A-60 fire rating when 15 inches (38.1 cm) of approved structural insulation extends down the penetrant's exposed fire side.

Penetrations D4, D6 - A bronze flanged copper spigot with 15-inch (38.1 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel plate will provide a Class A-0 fire rating for a bronze flanged copper pipe. Fifteen inches (38.1 cm) of approved structural insulation extending down the penetrant's fire side will not provide a Class A-60 fire rating.

Penetration D5 - A bronze flanged copper spigot with 5-1/2 inch (14 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel plate will provide a Class A-0 fire rating for a bronze flanged copper pipe. Fifteen inches (38.1 cm) of approved structural insulation extending down the penetrant's fire side will provide a Class A-60 fire rating.

Penetration D7 - A continuous copper pipe in a steel spigot with 15-inch (38.1 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel plate welded all around to the plate and packed with fire sealant to a 1-inch (2.5 cm) depth in both ends of the spigot will provide a Class A-0 fire rating. Fifteen inches (38.1 cm) of approved structural insulation extending down the penetrant's fire side will provide a Class A-60 fire rating.

Penetration D8 - A continuous copper pipe in a steel spigot with 6-inch (15.2 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel plate and packed with fire sealant to a 1-inch (2.5 cm) depth in both ends of the spigot and welded all around to the plate will provide a Class A-0 fire rating. Fifteen inches (38.1 cm) of approved structural insulation extending down the penetrant's fire side will not provide a Class A-60 fire rating.

Penetration D9 - A continuous copper pipe in a steel spigot with a 3-inch (7.6 cm) extension on the fire exposed side of a 3/16-inch (0.5 cm) steel plate and a 15-inch (38.1 cm) extension and a terminal tube on the unexposed side of the plate will provide a Class A-0 fire rating. Fifteen inches (38.1 cm) of approved structural insulation extending down the penetrant's fire side will provide a Class A-60 fire rating.

Penetration D10 - A continuous copper pipe in a steel spigot with 3-inch (7.6 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel plate and a terminal tube on the extension of the fire exposed side of the plate will pass a Class A-0 fire rating. Fifteen inches (38.1 cm) of approved structural insulation extending down the penetrant's fire exposed side will not provide a Class A-60 fire rating.

Penetration D11 - A continuous copper pipe brazed at both ends of a steel spigot with 15-inch (38.1 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel plate will pass a Class A-0 fire rating. Fifteen inches (38.1 cm) of approved structural insulation extending down the penetrant's fire exposed side will provide a Class A-60 fire rating.

Penetration D12 - A continuous copper pipe brazed to both ends of a steel spigot with 3-inch (7.6 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel plate will pass a Class A-0 fire rating. Fifteen inches (38.1 cm) of approved structural insulation extending down the penetrant's fire exposed side will not provide a Class A-60 fire rating.

Penetration D13 - A flanged steel spigot with 15-inch (38.1 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel plate and flanged to a PVC pipe will provide a Class A-0 fire rating. Fifteen inches (38.1 cm) of approved structural insulation extending down the penetrant's fire side will provide a Class A-60 fire rating.

Penetration D14 - A steel spigot with 3-inch (7.6 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel plate and threaded to a PVC pipe will not provide a Class A-0 fire rating. Six inches (15.2 cm) of approved structural insulation extending down the penetrant's fire side will provide a Class A-60 rating.

Penetration D15 - A continuous PVC pipe in a steel spigot with 15-inch (38.1 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel plate and packed with fire sealant to a 1-inch (2.5 cm) depth in both ends of the spigot and welded all around to the plate will provide a Class A-0 fire rating. Fifteen inches (38.1 cm) of approved structural insulation down the penetrant's fire side will provide a Class A-60 fire rating.

Penetration D16 - A continuous PVC pipe in a steel spigot with 3-inch (7.6 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel plate and packed with fire sealant to a 1-inch (2.5 cm) depth in both ends of the spigot and welded all around to the plate will provide a Class A-0 fire rating. Six inches (15.2 cm) of approved structural insulation down the penetrant's fire side will provide a class A-60 fire rating.

Penetration D17 - A 12-inch (30.5 cm) outer diameter steel spigot with 18-inch (45.7 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel plate and attached to a 22 gauge, 12-inch (30.5 cm) circular duct will provide a Class A-0 fire rating. Eighteen inches (45.7 cm) of approved structural insulation extending down the penetrant's fire exposed side will not provide a Class A-60 fire rating.

Penetration D18 - A 4-1/2 inch (11.4 cm) outer diameter steel spigot with an 18-inch (45.7 cm) extension on the fire exposed side of a 3/16-inch (0.5 cm) steel plate and a 6-inch (15.2 cm) extension with an approved 8-inch by 8-inch (20.3 cm by 20.3 cm) fire damper on the non-fire side will provide a Class A-0 rating. Eighteen inches (45.7 cm) of approved structural insulation extending down the fire exposed side of a steel spigot with a 6-inch (15.2 cm) outer diameter and an 18-inch (45.7 cm) extension on the fire exposed side of a 3/16-inch (0.5 cm) steel plate and a 6-inch (15.2 cm) extension with an approved 10-inch by 10-inch (25.4 cm by 25.4 cm) fire damper on the non-fire side will provide a Class A-60 fire rating.

Penetration D19 - The multiple cable transit extended through a 3/16-inch (0.5 cm) steel plate and failed the Class A-0 fire tests by permitting the occurrence of flame and smoke on the unexposed side of the sample. It appeared that the cable on the unexposed side of the sample caught fire because of the heat radiating through the steel deck surrounding the cable transit. Nine inches (22.9 cm) of approved structural insulation extending down the penetrant's fire exposed side provided a Class A-60 fire rating.

Penetration D20 - A steel spigot with a 3-inch (7.6 cm) extension on the fire side of a 3/16-inch (0.5 cm) steel plate and a 15-inch (38.1 cm) extension with a terminal tube on the non-fire side will provide a Class A-0 fire rating. Three inches (7.6 cm) of approved structural insulation on the penetrant's fire exposed side and 15 inches (38.1 cm) of identical insulation on the penetrant's unexposed fire side will not provide a Class A-60 fire rating.

Penetration D21 - A steel spigot with a 3-inch (7.6 cm) extension on the fire side of a 3/16-inch (0.5 cm) steel plate and a 15-inch (38.1 cm) extension with a terminal tube on the non-fire side will provide a Class A-0 fire rating. Six inches (15.2 cm) of approved structural insulation extending down the penetrant's exposed fire side will provide a Class A-60 fire rating.

8.0 RECOMMENDATIONS

8.1 Penetration Designs

It is recommended that UL 1479 (ASTM E814) be considered as a fire resistance performance test for evaluating penetration designs submitted for U.S. Coast Guard approval. Both UL Standard 1479 and ASTM E814 would require some modifications to comply with specific U.S. Coast Guard regulations governing the passage of smoke and the acceptable limits of temperature rise.

It is recommended that the penetrations which successfully passed the UL Standard 1479 be considered as design guidelines for penetration samples. Based on the test results, samples which follow these guidelines could be expected to pass the modified UL performance test.

8.2 Future Testing

A second phase of testing is recommended to:

- Utilize test data to modify and retest the penetrations which failed.
- Identify and test other practical designs to expand the number of design guidelines available to shipbuilders.
- Permit more generalized descriptions of penetrations which will meet the Class A-0 and A-60 requirements.

REFERENCES

1. Department of Transportation, U.S. Coast Guard Specifications, Subchapter Q (Title 46, CFR 164.007).
2. Navigation and Vessel Inspection Circular 6-80; Department of Transportation, U.S. Coast Guard.
3. Structural Fire Protection Standards: Specifications, Procedures, and Testing TP 439; Ship Safety Branch, Transport Canada Coast Guard.
4. Miscellaneous Electrical Equipment List CG-293; Department of Transportation, U.S. Coast Guard, 1962.
5. UL 1479, Standard for Fire Tests of Through-Penetration Firestops; Underwriters Laboratories, First Edition, January 1983.
6. ASTM E814, Standard Method of Fire Tests of Through-Penetration Fire Stops; American Society for Testing and Materials, Current Edition, July 1983.

APPENDIX A
SAMPLE PENETRATIONS

Class A-0 Samples

	<u>Sample</u>	<u>Description</u>
1.	D1	A continuous steel pipe with a steel collar welded all around the pipe. The collar is then welded all the way around to a 3/16-inch (0.5 cm) steel test plate.
2.	D2	A flanged steel spigot (with 15-inch (38.1 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel collar) bolted to a bronze flanged copper pipe. The steel collar is welded all the way around to both the steel spigot and to a 3/16-inch (0.5 cm) steel test plate.
3.	D3	A flanged steel spigot (with 5-1/2 inch (14 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel collar) bolted to a bronze flanged copper pipe. The steel collar is welded all the way around to both the steel spigot and to a 3/16-inch (0.5 cm) steel test plate.
4.	D4	A bronzed flanged copper spigot (with 15-inch (38.1 cm) extensions on both sides of a 3/16-inch (0.5 cm) bronze plate) bolted to a bronze flanged copper pipe. The bronze plate is brazed all around to the copper spigot and bolted to a 3/16-inch (0.5 cm) steel collar which is welded to a 3/16-inch (0.5 cm) steel test plate.
5.	D5	A bronze flanged copper spigot (with 5-1/2 inch (14 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel collar) bolted to a bronzed flanged copper pipe. The steel collar is brazed all around to the copper spigot and welded all around to a 3/16-inch (0.5 cm) steel test plate.
6.	D6	A bronze flanged copper spigot (with 15-inch (38.1 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel collar) bolted to a bronzed flanged copper pipe. The steel collar is brazed all around to the copper spigot and welded all around to a 3/16-inch (0.5 cm) steel test plate.
7.	D7	A continuous copper pipe in a steel spigot. The steel spigot had 15-inch (38.1 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel test plate and was welded all the way around to the plate. Fire sealant was packed inside both ends of the spigot around the copper pipe to a 1-inch (2.5 cm) depth.

8. D8 A continuous copper pipe in a steel spigot. The steel spigot had 6-inch (15.2 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel test plate and was welded all the way around the plate. Fire sealant was packed inside both ends of the spigot around the copper pipe to a 1-inch (2.5 cm) depth.
9. D9 A continuous copper pipe in a steel spigot. The steel spigot had a 3-inch (7.6 cm) extension on the fire exposed side of the 3/16-inch (0.5 cm) steel test plate and a 15-inch (38.1 cm) extension with a terminal tube on the unexposed fire side of the panel. The steel spigot was welded all the way around to the test plate.
10. D10 A continuous copper pipe in a steel spigot. The steel spigot had 3-inch (7.6 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel test plate and a terminal tube on its fire exposed side. The steel spigot was welded all the way around to the test plate.
11. D11 A continuous copper pipe in a steel spigot. The steel spigot had 15-inch (38.1 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel test plate. The steel spigot was brazed all the way around at both its ends to the copper pipe while it was welded all the way around to the test plate.
12. D12 A continuous copper pipe in a steel spigot. The steel spigot had 3-inch (7.6 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel test plate. The steel spigot was brazed all the way around at both its ends to the copper pipe while it was welded all the way around to the test plate.
13. D13 A flanged steel spigot bolted to flanged PVC pipe. The steel spigot had 15-inch (38.1 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel test plate and was welded all the way around the plate.
14. D14 A steel spigot threaded at both ends to PVC pipe. The steel spigot had 3-inch (7.6 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel test plate and was welded all around to the test plate.
15. D15 A continuous PVC pipe in a steel spigot. The steel spigot had 15-inch (38.1 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel test plate and was welded all the way around to the plate. Fire sealant was packed inside both ends of the spigot around the PVC pipe to 1-inch (2.5 cm) depth.
16. D16 A continuous PVC pipe in a steel spigot. The steel spigot had 3-inch (7.6 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel test plate and was welded all the way around the plate. Fire sealant was packed inside both ends of the spigot around the PVC pipe to a 1-inch (2.5 cm) depth.

17. D17 A steel spigot connected to a circular 22 gauge duct. The steel spigot had 18-inch (45.7 cm) extensions on both sides of a 3/16-inch (0.5 cm) steel test plate and was welded all the way around to the plate. A circular 22 gauge duct could not be fitted to the fire exposed side of the test plate but a 22 gauge blank end cap was fitted over the fire exposed end of the steel spigot.
18. An error by the sample manufacturer resulted in two different diameter spigots and different size fire dampers.
- D18(A-0) A 4-1/2 inch (11.4 cm) outer diameter steel spigot and an approved fire damper in an 8"x8"x26" (20.3 cm x 20.3 cm x 66 cm) steel box. The steel spigot was welded all the way around to a 3/16-inch (0.5 cm) steel test plate and had an 18-inch (45.7 cm) extension on the fire exposed side of the plate and a 6-inch (15.2 cm) extension on the unexposed fire side. The fire damper box was attached to the 6-inch (15.2 cm) extension.
- D18(A-60) A 6-inch (15.2 cm) outer diameter steel spigot and an approved fire damper for a 10"x10"x26" (25.4 cm x 25.4 cm x 66 cm) steel box. The steel spigot was welded all the way around to a 3/16-inch (0.5 cm) steel test plate and had an 18-inch (45.7 cm) extension on the fire exposed side of the plate and a 6-inch (15.2 cm) extension on the unexposed fire side. The fire damper box was attached to the 6-inch (15.2 cm) extension.
19. D19 A multi-cable transit with six types of marine electrical cable complying with Canadian Coast Guard Ship Safety Electrical Standards. The transit device was welded all the way around to a 3/16-inch (0.5 cm) steel test plate.
20. D20 A steel spigot and a terminal tube containing a 2-inch (5.1 cm) diameter marine electrical cable. The steel spigot was welded all around to a 3/16-inch (0.5 cm) steel test plate and had a 3-inch (7.6 cm) extension on the fire exposed side of the plate. The steel spigot had a 15-inch (38.1 cm) extension and a terminal tube on the unexposed fire side of the test plate. The electrical cable complied with Canadian Coast Guard Ship Safety Electrical Standards.
21. D21 A steel spigot and a terminal tube containing a 2-inch (5.1 cm) diameter marine electrical cable. The steel spigot was welded all the way around to a 3/16-inch (0.5 cm) steel test plate and had a 3-inch (7.6 cm) extension on the fire exposed side of the plate. The steel spigot had a 15-inch (38.1 cm) extension and a terminal tube on the unexposed fire side of the test plate. The electric cable complied with Canadian Coast Guard Ship Safety Electrical Standards.

Class A-60 Samples

Same as Class A-0 samples but with insulation attached to fire side of penetration and test plate. Sample D20 did have insulation on both the fire side and the unexposed fire side. The insulation depths are shown on the detailed drawings in the appropriate data sections of Appendix C.

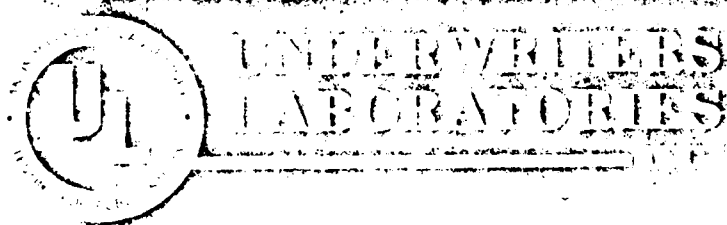
NOTE: Spigot refers to a length of pipe which either replaces or encloses a continuous run of pipe, duct, or electrical cable.

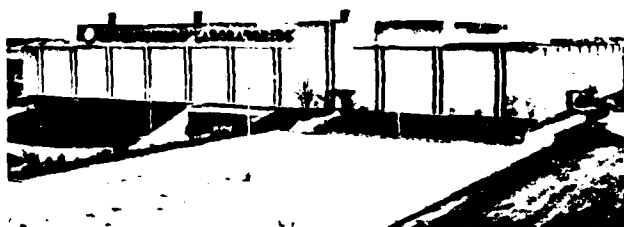
A detailed drawing and technical description for each penetration assembly is located in the individual data section for each sample in Appendix C.

UL 1479

STANDARD & SAFETY

FIRE TESTS OF THROUGH-PENETRATION FIRESTOPS





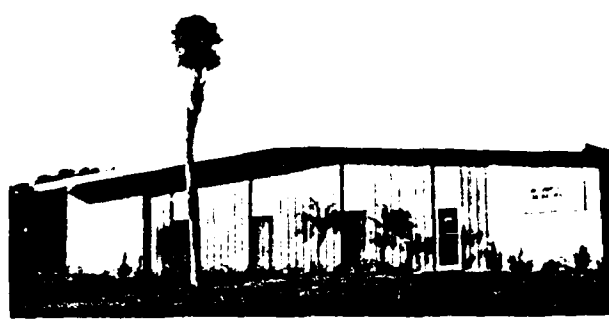
Northbrook, Illinois



Melville, New York



Santa Clara, California



Tampa, Florida

UNDERWRITERS LABORATORIES INC.

AN INDEPENDENT NOT-FOR-PROFIT ORGANIZATION
TESTING FOR PUBLIC SAFETY

Underwriters Laboratories Inc., founded in 1894, is chartered as a not-for-profit organization without capital stock, under the laws of the State of Delaware, to establish, maintain, and operate laboratories for the examination and testing of devices, systems and materials to determine their relation to hazards to life and property.

A complete description of the organization, purposes, and methods of Underwriters Laboratories Inc. is given in a separate pamphlet entitled "TESTING FOR PUBLIC SAFETY."

The names of manufacturers who have demonstrated an ability to produce products meeting UL requirements are published annually in the following Product Directories.

Building Materials
Fire Protection Equipment
Fire Resistance
Recognized Component
Electrical Appliance and Utilization Equipment
Electrical Construction Materials
Hazardous Location Equipment

General Information From Electrical Construction
Materials Directory
Marine Products
Automotive, Burglary Protection, and Mechanical
Equipment
Gas and Oil Equipment
Supplements to Directories

The price list for these publications and ordering information may be obtained upon request from UL, Publications Stock, 333 Pfingsten Road, Northbrook, Illinois 60062.

A Catalog of UL Standards for Safety with costs and ordering information is also available from this office.



UNDERWRITERS LABORATORIES INC.

an independent, not-for-profit organization testing for public safety

1285 Walt Whitman Road, Melville, L.I., N.Y. 11747
1655 Scott Boulevard, Santa Clara, Calif. 95050
2602 Tampa East Blvd., Tampa, Fla. 33619
333 Pfingsten Road, Northbrook, Ill. 60062

January 5, 1983

**STANDARD FOR
FIRE TESTS OF THROUGH-PENETRATION FIRESTOPS**

UL 1479, FIRST EDITION

Accompanying this transmittal notice is a copy of the first edition of UL 1479.

THIS EDITION OF THE STANDARD IS NOW IN EFFECT.

The requirements in this standard are substantially in accordance with UL's bulletins on this subject dated April 9, 1981 and June 9, 1982, except for the inclusion of paragraph 5.4, which was inadvertently omitted from the proposals in these bulletins.

Revised and/or additional pages may be issued from time to time.

JANUARY 5, 1983

1

UL 1479
STANDARD FOR
FIRE TESTS OF THROUGH-PENETRATION FIRESTOPS

Products covered by this standard were previously tested under the Standards for Fire Tests of Building Construction and Materials, UL 263, and Fire Tests of Door Assemblies, UL 10B.

FIRST EDITION

First ImpressionJanuary 5, 1983

COPYRIGHT © 1983 UNDERWRITERS LABORATORIES INC.

UL's Standards for Safety are copyrighted to protect UL's publication rights, not to restrict their use in product design or evaluation. See paragraph E of the Foreword.

B-5/B-6

TABLE OF CONTENTS

Foreword	4
General	5
1. Scope	5
2. Glossary	5
3. Units of Measurement	5
Performance	5
4. Fire Exposure Test	5
5. Hose Stream Test	11
Rating	11
6. F Rating	11
7. T Rating	12
8. Correction	12
Report	12
9. Results	12

FOREWORD

A. This standard contains a description of the basic test method(s) for evaluating products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this standard. This test method(s) is based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. It is subject to revision as further experience and investigation may show is necessary or desirable.

B. The consistent and uniform production of the product so that it will perform in the manner indicated by the coverage is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which performs in a specified manner will not necessarily be judged to be eligible for coverage if, when examined and tested, it is found to have other features which impair the significance associated with such performance.

D. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgement given with due consideration to the necessary limitations of practical operation and state of the art at the time the standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this standard.

E. Many tests required by the standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

GENERAL

1. Scope

1.1 These requirements cover through-penetration firestops of various materials and construction that are intended for use in openings in fire resistive wall or floor-ceiling assemblies, or both.

1.2 The method of testing through-penetration firestops as specified by these requirements consists of exposure of test samples to a fire of standard time and temperature and to an application of a hose stream. Ratings are then established on the basis of (1) the length of time the firestop resists fire before the first development of through openings or flaming on the unexposed surface, (2) acceptable limitation of thermal transmission, and (3) acceptable performance under the application of the hose stream. Two ratings are established for each test sample; an F rating based on flame occurrence on the unexposed side of the test sample and acceptable hose stream performance, and a T rating based on temperature rise and flame occurrence on the unexposed side of the test sample and acceptable hose stream performance.

1.3 Tests conducted in accordance with these requirements are intended to demonstrate the performance of through-penetration firestops during exposure to fire, but are not intended to determine acceptability of firestops for use after exposure to fire.

1.4 These requirements do not cover devices that penetrate fire resistive floors and walls but terminate on the opposite side, as, for example, an outlet box and fitting.

2. Glossary

2.1 For the purpose of this standard the following definitions apply.

2.2 **THROUGH-PENETRATION FIRESTOP** - A specific construction consisting of (1) the material(s) that fills the opening and (2) the penetrating items, such as cables, cable trays,

conduits, ducts, and pipes, along with their means of support through the wall or floor opening, that is intended to prevent spread of fire.

2.3 **TEST SAMPLE** - The through-penetration firestop being tested.

2.4 **TEST ASSEMBLY** - The wall or floor into which the test sample is mounted or installed.

3. Units of Measurement

3.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

PERFORMANCE

4. Fire Exposure Test

Test Sample

4.1 Each representative construction type of through penetration firestop for which rating is desired shall be tested.

4.2 Penetrating items are to be installed in the test sample so that they extend 12 ± 1 inches (300 ± 25 mm) from the exposed side, and 36 ± 1 inches (910 ± 25 mm) from the unexposed side. The extended portions of the penetrating items on the unexposed side are to be supported by methods intended to be employed in field installation. The individual ends of the penetrating items are to be covered to prevent excessive transfer of gasses through the test sample.

4.3 The periphery of the test sample is to be not closer than 1-1/2 times the thickness of the test assembly, or a minimum of 12 inches (300 mm), to the furnace edge, whichever is greater. The distance between the test sample periphery and furnace edge may be reduced if it is demonstrated that the edge effects do not affect the test results.

Conditioning

4.4 Prior to fire testing, each test sample and test assembly is to be conditioned, if necessary, to provide a moisture condition representative of that likely to exist in similarly-constructed buildings. The test assembly may be conditioned independent of the conditioning of the test samples. The moisture condition is to be established by storage in air having 50 percent relative humidity at 73°F (23°C) until an equilibrium moisture condition is achieved. If it is impractical to achieve this equilibrium moisture condition, the test may be conducted when the dampest portion of the test assembly and test sample have achieved an equilibrium moisture content resulting from storage in air having 50 to 75 percent relative humidity at 73±5°F (23±3°C).

Exception: These requirements may be waived if (1) an equilibrium moisture condition is not achieved within a 12-month conditioning period or (2) the construction is such that hermetic sealing resulting from the conditioning has prevented drying of the interior of the test sample or assembly, and the conditioning need then be continued only until the test assembly has developed sufficient strength to retain the test sample securely in position.

4.5 The method for determining the relative humidity within hardened concrete by use of electric sensing elements is described in Appendix I of a paper by Carl A. Menzel, "A Method for Determining the Moisture Condition of Hardened Concrete in Terms of Relative Humidity," Proceedings, ASTM, Volume 55, Page 1085 (1955). A similar procedure with electric sensing elements may be used to determine the relative humidity within a test assembly and test sample made of materials other than concrete.

Protection of Assembly and Sample

4.6 The testing equipment and test sample and assembly are to be protected from any condition of wind or weather that might influence the test results. The ambient air temperature at the beginning of the test is to lie within the range of 50 to 90°F (10 to 32°C). The velocity of air across the unexposed surface of the test sample, measured

immediately before the test begins, is not to exceed 4.4 feet per second (1.3 m/s) as determined by an anemometer placed at right angles to the unexposed surface. If mechanical ventilation is employed during the test, an air stream is not to be directed across the surface of the sample.

Furnace Temperature Control and Measurement

4.7 The temperature of the furnace is to be controlled so that the area under the measured temperature-time curve of furnace temperature, obtained by averaging the results from thermocouple (see paragraphs 4.11-4.15) or pyrometer readings, is within (1) 10 percent of the corresponding area under the standard temperature-time curve illustrated in Figure 4.1 for fire tests for 1 hour or less duration, (2) 7.5 percent for tests longer than 1 hour but not longer than 2 hours, and (3) 5 percent for tests exceeding 2 hours in duration. The points on the curve that determine its character are:

50-90°F (10 to 32°C)	at 0 minutes
1000°F (538°C)	at 5 minutes
1300°F (704°C)	at 10 minutes
1550°F (843°C)	at 30 minutes
1700°F (927°C)	at 1 hour
1850°F (1010°C)	at 2 hours
2000°F (1093°C)	at 4 hours
2300°F (1260°C)	at 8 hours

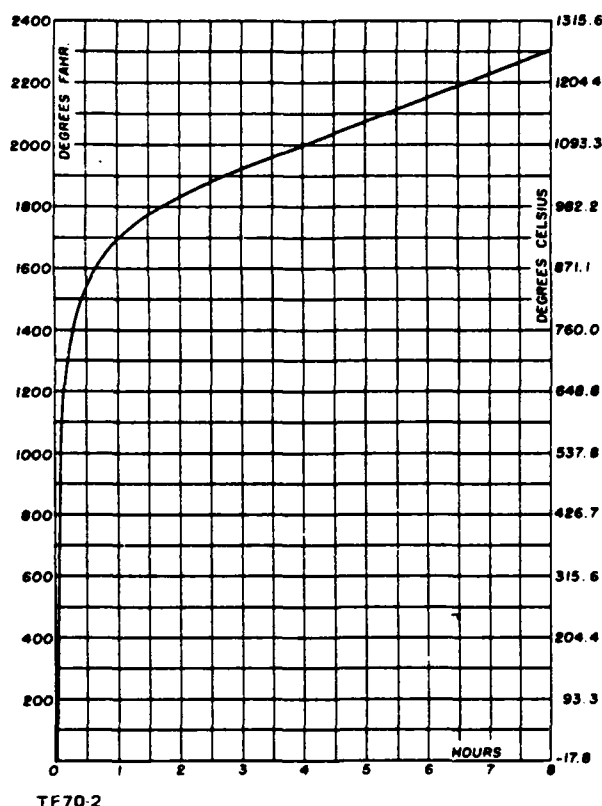
For a more precise definition of the temperature-time curve, see Table 4.1.

4.8 The measured temperature to be compared with the standard temperature-time curve is to be the average temperature obtained from the readings of thermocouples symmetrically disposed and distributed within the test furnace to indicate the temperature near all parts of the test assembly.

4.9 A minimum of three thermocouples are to be used, and there are to be no fewer than five thermocouples per 100 square feet (9.3 m²) of floor surface, and no fewer than nine thermocouples per 100 square feet of wall surface. The floor surface or wall surface area is to be the gross area of test-assembly and -sample areas.

4.10 The junctions of the thermocouples are to be placed 12 inches (305 mm) from the exposed face of a floor test assembly and 6 inches (152 mm) from the exposed face of a wall test assembly.

FIGURE 4.1
TIME-TEMPERATURE CURVE



4.11 The temperatures are to be read at intervals of 5 minutes or less during the first 2 hours and at intervals of 10 minutes or less thereafter.

Furnace Thermocouple Preparation

4.12 Each furnace thermocouple is to be enclosed in a sealed protection tube. The exposed combined length of protection tube and thermocouple in the furnace chamber is to be not less than 12 inches (0.3 m). Other types of protection tubes may be used provided that the temperature measurements are within the limits of accuracy specified in paragraph 4.13.

4.13 The time constant of the protected thermocouple assembly is to lie within the range of 5.0 to 7.2 minutes. A typical thermocouple assembly complying with this time constant requirement may be fabricated by fusion-welding the twisted ends of No. 18 AWG (0.82 mm²) Chromel-Alumel wires, mounting the leads in porcelain insulators and inserting the assembly into a standard weight nominal 1/2-inch iron, steel, or Inconel pipe, and sealing the end of the pipe that is inside the furnace. The thermocouple junction is to be inside the pipe, 1/2 inch (13 mm) from the sealed end.

Unexposed Side Temperature Measurement

Sample Thermocouple Location

4.14 Temperature measurements are to be made by thermocouples placed at each of the following locations on the unexposed side of the test sample and test assembly, as illustrated in Figure 4.2.

A. At a point on the surface of the test sample, 1 inch (25 mm) from one of each type of through-penetrating item employed in the field of the through-penetration firestop material. Thermocouples are to be covered by a pad (see paragraphs 4.16 and 4.19); however, if the grouping of items through the test sample does not permit use of a pad, the thermocouple need not be used.

B. At a minimum of one point on the through-penetration firestop material surface at the periphery of the test sample.

C. At at least three points on the through-penetration firestop material surfaces approximately equidistant from a penetrating item or group of penetrating items in the field of the firestop and the periphery.

D. At a point on any frame installed around the perimeter of the opening.

E. At a point on the unexposed surface of the wall or floor assembly at least 12 inches (0.3 m) from any opening.

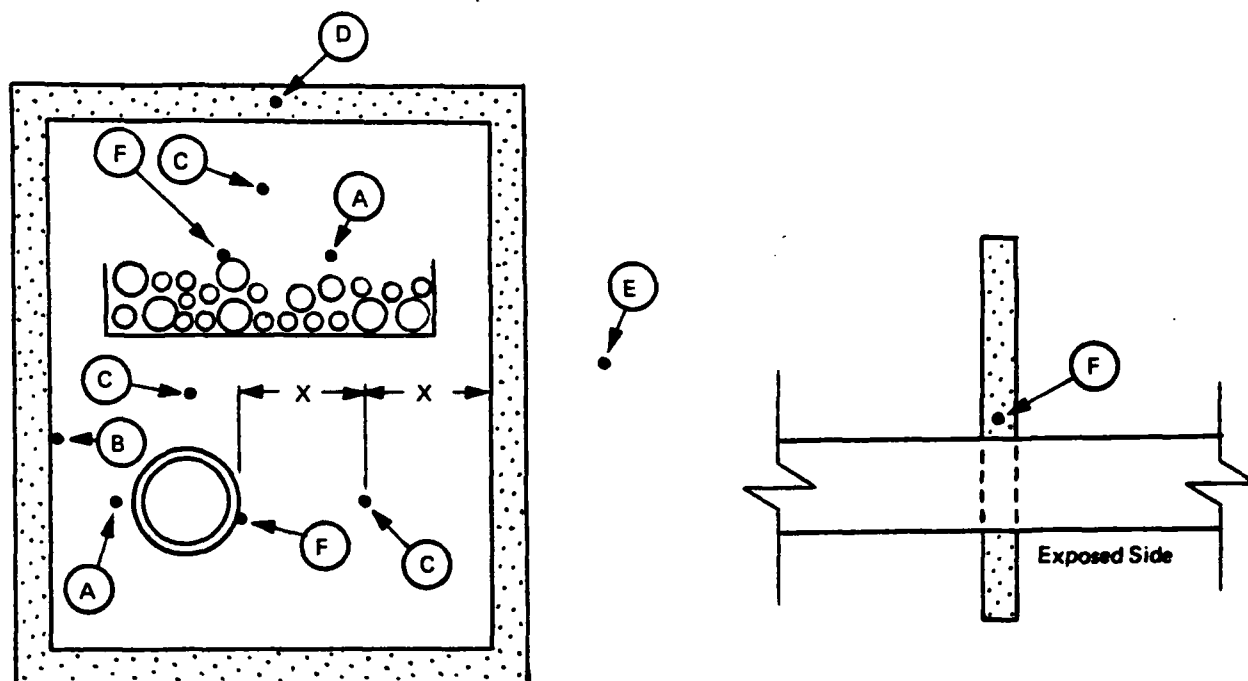
F. At one point on each type of through-penetrating item.

TABLE 4.1
STANDARD TIME-TEMPERATURE CURVE FOR CONTROL
OF FIRE TESTS

(TT-3)

Time, hr: min.	Temperature, degrees F	Area Above 68°F Base		Temperature degrees C	Area Above 20°C Base	
		degrees F, min.	degrees F, hr.		degrees C, min.	degrees, C hr.
0:00	68	00	0	20	00	0
0:05	1 000	2 330	39	538	1 290	22
0:10	1 300	7 740	129	704	4 300	72
0:15	1 399	14 150	236	760	7 860	131
0:20	1 462	20 970	350	795	11 650	194
0:25	1 510	28 050	468	821	15 590	260
0:30	1 550	35 360	589	843	19 650	328
0:35	1 584	42 860	714	862	23 810	397
0:40	1 613	50 510	842	878	28 060	468
0:45	1 638	58 300	971	892	32 390	540
0:50	1 661	66 200	1 103	905	36 780	613
0:55	1 681	74 220	1 237	916	41 230	687
1:00	1 700	82 330	1 372	927	45 740	762
1:05	1 718	90 540	1 509	937	50 300	838
1:10	1 735	98 830	1 647	946	54 910	915
1:15	1 750	107 200	1 787	955	59 560	993
1:20	1 765	115 650	1 928	963	64 250	1 071
1:25	1 779	124 180	2 070	971	68 990	1 150
1:30	1 792	132 760	2 213	978	73 760	1 229
1:35	1 804	141 420	2 357	985	78 560	1 309
1:40	1 815	150 120	2 502	991	83 400	1 390
1:45	1 826	158 890	2 648	996	88 280	1 471
1:50	1 835	167 700	2 795	1 001	93 170	1 553
1:55	1 843	176 550	2 942	1 006	98 080	1 635
2:00	1 850	185 440	3 091	1 010	103 020	1 717
2:10	1 862	203 330	3 389	1 017	112 960	1 882
2:20	1 875	221 330	3 689	1 024	122 960	2 049
2:30	1 888	239 470	3 991	1 031	133 040	2 217
2:40	1 900	257 720	4 295	1 038	143 180	2 386
2:50	1 912	276 110	4 602	1 045	153 390	2 556
3:00	1 925	294 610	4 910	1 052	163 670	2 728
3:10	1 938	313 250	5 221	1 059	174 030	2 900
3:20	1 950	332 000	5 533	1 066	184 450	3 074
3:30	1 962	350 890	5 848	1 072	194 940	3 249
3:40	1 975	369 890	6 165	1 079	205 500	3 425
3:50	1 988	389 030	6 484	1 086	216 130	3 602
4:00	2 000	408 280	6 805	1 093	226 820	3 780
4:10	2 012	427 670	7 128	1 100	237 590	3 960
4:20	2 025	447 180	7 453	1 107	248 430	4 140
4:30	2 038	466 810	7 780	1 114	259 340	4 322
4:40	2 050	486 560	8 110	1 121	270 310	4 505
4:50	2 062	506 450	8 441	1 128	281 360	4 689
5:00	2 075	526 450	8 774	1 135	292 470	4 874
5:10	2 088	546 580	9 110	1 142	303 660	5 061
5:20	2 100	566 840	9 447	1 149	314 910	5 248
5:30	2 112	587 220	9 787	1 156	326 240	5 437
5:40	2 125	607 730	10 129	1 163	337 630	5 627
5:50	2 138	628 360	10 473	1 170	349 090	5 818
6:00	2 150	649 120	10 819	1 177	360 620	6 010
6:10	2 162	670 000	11 167	1 184	372 230	6 204
6:20	2 175	691 010	11 517	1 191	383 900	6 398
6:30	2 188	712 140	11 869	1 198	395 640	6 594
6:40	2 200	733 400	12 223	1 204	407 450	6 791
6:50	2 212	754 780	12 580	1 211	419 330	6 989
7:00	2 225	776 290	12 938	1 218	431 270	7 188
7:10	2 238	797 920	13 299	1 225	443 290	7 388
7:20	2 250	819 680	13 661	1 232	455 380	7 590
7:30	2 262	841 560	14 026	1 239	467 540	7 792
7:40	2 275	863 570	14 393	1 246	479 760	7 996
7:50	2 288	885 700	14 762	1 253	492 060	8 201
8:00	2 300	907 960	15 133	1 260	504 420	8 407

FIGURE 4.2
TEMPERATURE MEASUREMENT LOCATIONS^a



^a See paragraph 4.14 for description of letter symbols

S2189

4.15 Temperature measurements may be made at locations in addition to those described in paragraph 4.14 for the purpose of evaluating the performance of the firestop.

4.16 Temperatures on the surface of the through-penetration firestop and test assembly are to be measured with thermocouples placed under flexible pads (see paragraph 4.19). The pads are to be held firmly against the surface and are to fit closely about the thermocouples. Each thermocouple junction is to be located under the center of each pad. The thermocouple leads under the pads are to be not larger than No. 18 AWG (0.82 mm²) and are to be electrically insulated with heat- and moisture-resistant coverings.

4.17 Temperatures on the penetrating items are to be measured with thermocouples located 1 inch (25 mm) from the unexposed surface of the

through-penetration firestop material. The thermocouple bead is to be held firmly against the penetrating item. The thermocouple leads are not to be larger than No. 22 AWG (0.32 mm²) and are to be electrically insulated with heat- and moisture-resistant coverings. The pads as described in paragraph 4.19, are to be held firmly against the penetrating item and are to fit closely about the thermocouples.

4.18 Temperatures are to be measured at intervals of 15 minutes or less until a reading exceeding 212°F (100°C) has been obtained at any one point. Thereafter, the readings may be taken more frequently at the discretion of testing personnel, but the intervals need not be less than 5 minutes.

Thermocouple Pads

4.19 Each thermocouple used to measure temperatures on the unexposed side of the sample and assembly is to be covered with a flexible pad that:

- A. Is of inorganic material that can be bent without breaking,
- B. Has a length and a width of 2 ± 0.04 inch (50 ± 1 mm),
- C. Is 0.40 ± 0.05 inch (10 ± 1 mm) thick,
- D. Has a density of 31.2 ± 0.6 pound per cubic foot per (500 ± 10 kg/m³), and
- E. Has a thermal conductivity at 150°F (65.6°C) of 0.38 ± 0.027 Btu inch per hour per square foot per degree F (0.055 ± 0.0039 W/m·K).

Differential Pressure Measurements

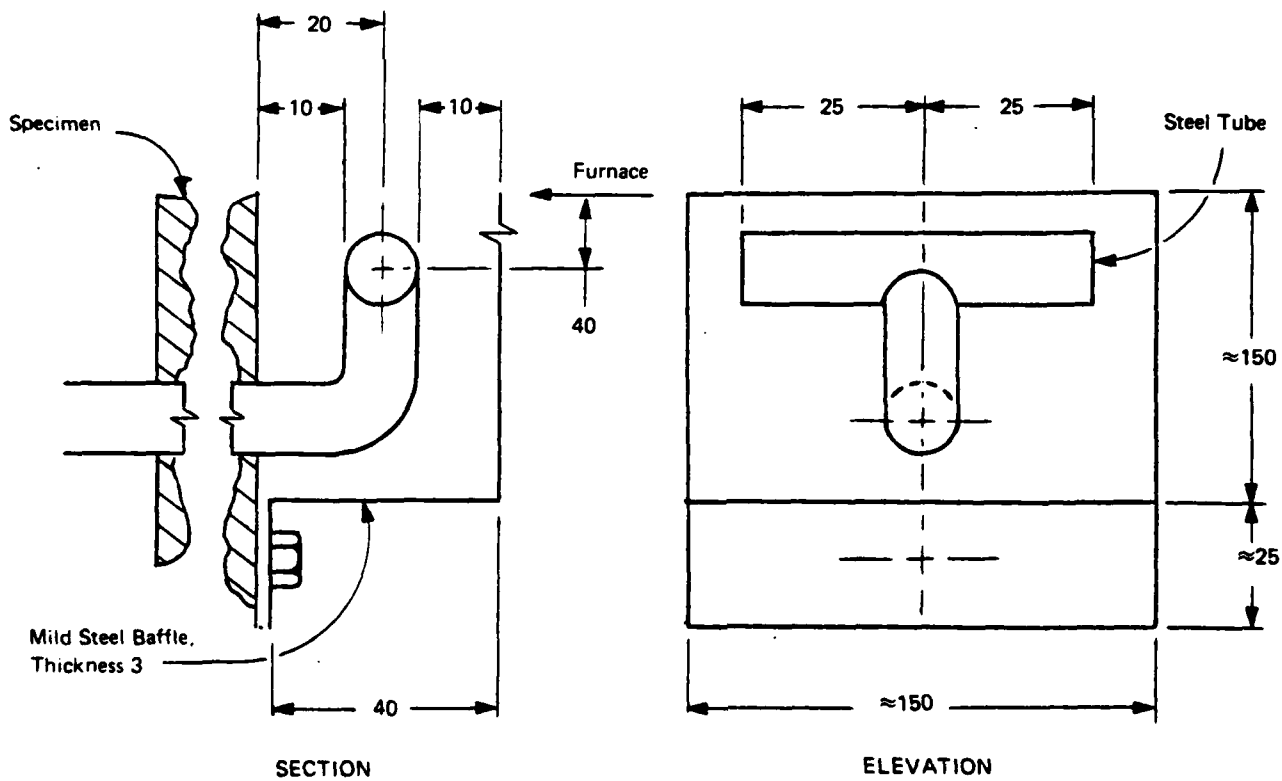
General

4.20 The appropriate differential pressure between the exposed and unexposed surfaces of the test assembly (see paragraph 4.24) is to be controlled within ± 20 percent of the intended value during the test (excluding the first 10 minutes).

4.21 The differential pressure between the exposed and unexposed surfaces of the test assembly is to be measured at three points on each side of the wall or floor, 0.78 inch (20 mm) from the surface of the assembly, as follows:

- A. At the center and the quarter points of the vertical center line for a wall assembly, and
- B. At the center of and the quarter points of the longitudinal center line for a floor assembly.

FIGURE 4.3
PRESSURE MEASUREMENT PROBE



S2190

All Dimensions in Millimeters

Pressure Measurement Apparatus

4.22 The differential pressure between the exposed and the unexposed surface of the test assembly is to be measured by means of a manometer or equivalent transducer capable of reading pressure within an accuracy of 0.01 inch water (2.5 Pa).

4.23 The pressure measuring probe tips are to be as illustrated in Figure 4.3 or the equivalent, and manufactured from stainless steel or equivalent material.

Differential Pressure Selection

4.24 The differential pressure employed in testing is to be determined by either (1) code requirements, (2) the design pressure that may occur in the type of installation for which the test is proposed, or (3) other circumstances.

Duration of Test

4.25 The test sample and assembly are to be subjected to fire exposure (1) for a period equal to the desired F rating (see Section 6) for the firestop or (2) until a through opening develops in, or flaming occurs on the unexposed side of, the test sample; whichever is less.

5. Hose Stream Test

5.1 A duplicate test sample and test assembly shall be subjected to a fire exposure test for a period equal to one-half of the desired F rating (see Section 6) but not more than 60 minutes. Immediately after the fire exposure, the test sample is to be subjected to the impact, erosion, and cooling effects of a hose stream, as described in Table 5.1, directed first at the middle and then at all other parts of the exposed face, with all changes in direction being made slowly.

5.2 The test sponsor may elect, with the advice and consent of the testing body, to conduct the hose stream test on the sample constructed for the fire exposure test. The hose stream test is to be conducted within 10 minutes of completion of the fire exposure test.

TABLE 5.1
PRESSURE AND DURATION – HOSE STREAM TEST

Desired F Rating (F), Minutes	Water Pressure at Base of Nozzle, PSI (kPa)	Duration of Application, Seconds per Square Foot (s/m ²) of Exposed Area ^a
240 ≤ F < 480	45 (310)	3.0 (32)
120 ≤ F < 240	30 (210)	1.5 (16)
90 ≤ F < 120	30 (210)	0.90 (9.7)
F < 90	30 (210)	0.60 (6.5)

^a The rectangular area of the wall or floor assembly into which the test assembly is mounted is to be considered as the exposed area, as the hose stream must traverse this calculated area during its application.

5.3 The stream is to be delivered through 2-1/2 inch (63.5 mm) hose and discharged through a National Standard playpipe of corresponding size equipped with a 1-1/8 inch (28.6 mm) discharge tip of the standard-taper, smooth-bore pattern without a shoulder at the orifice. The water pressure and duration of application is to be as specified in Table 5.1.

5.4 The nozzle orifice is to be 20 feet (6.1 m) from the center of the exposed surface of the test specimen if the nozzle is so located that, when directed at the center, its axis is normal to the surface of the test specimen. If otherwise located, its distance from the center is to be less than 20 feet by an amount equal to 1 foot (305 mm) for each 10 degrees of deviation from the normal.

RATING

6. F Rating

6.1 A through-penetration firestop shall remain in the opening during the fire test and hose stream test and shall comply with the following:

A. The sample shall withstand the fire test for the rating period without permitting the passage of flame through openings, or the occurrence of flaming on any element of the unexposed side of the sample.

B. The sample shall not develop any opening during the hose stream test that would permit a projection of water from the stream beyond the unexposed side.

7. T Rating

7.1 A through-penetration firestop shall remain in the opening during the fire test and hose stream test and shall comply with the following:

A. The transmission of heat through the sample during the rating period shall not raise the temperature measured by any thermocouple on the unexposed surface of the firestop or on any penetrating item by more than 325° F (163° C) above its initial temperature. Also, the sample shall withstand the fire test during the rating period without permitting the passage of flame through openings, or the occurrence of flaming on any element of the unexposed side of the sample.

B. During the hose stream test, the firestop shall not develop any opening that would permit a projection of water from the stream beyond the unexposed side.

8. Correction

8.1 When the indicated through-penetration firestop rating period is 60 minutes or more, it shall be increased or decreased by the following correction to compensate for significant variation of the measured test furnace temperature from the standard time-temperature curve within the limits of paragraph 4.7. The correction may be expressed by the following formula:

$$C = \frac{2I(A - A_s)}{3(A_s + L)}$$

where:

C = Correction in the same units as I,

I = Indicated fire-resistance period,

A = Area under the curve of measured average furnace temperature for the first three-fourths of the indicated period,

A_s = Area under the standard time-temperature curve for the first three-fourths of the indicated period, and

L = Lag correction in the same units as A and A_s [54° F-hours (30° C-hours); 3249° F-minute (1783° C-minute)].

REPORT

9. Results

9.1 The performance of samples during the tests in these requirements shall be reported. The report shall include the following:

A. A description of the assembly, materials, and penetrating items of the test firestop, including drawings depicting geometry, exact size (length, width, and thickness), and location of firestops within the test assembly.

B. The relative humidities of the test assembly and firestop materials, if applicable.

C. The temperature of the furnace and the unexposed side recorded during the standard fire test.

D. The F and T ratings for each firestop.

E. The measured differential pressure between the exposed and unexposed test assembly surfaces during the fire test and a statement of the basis for the chosen pressure.

F. Observations and significant details of the behavior of the firestops during the test and after the furnace fire is extinguished. These shall include any cracks, deformation, flaming, and smoke issuance, as well as any continued burning within the firestop after termination of the fire test.

THIS PAGE INTENTIONALLY LEFT BLANK

UL Standards for Safety are developed under a procedure which provides for participation and comment from the affected public as well as industry. The procedure takes into consideration a survey of known existing standards, and the needs and opinions of a wide variety of interests connected with the subject matter of the Standard. These interests include consumers, individuals associated with commerce, organized organizations, academicians, government officials, industry, and commercial users. Inspection authorities, consumer interests and others provide input to UL in the promulgating of UL Standards for Safety, and keeping them consistent with social and technological advances.



UNDERWRITERS
LABORATORIES

APPENDIX C

UL TEST REPORT

NOTE: ALL THERMOCOUPLE READINGS IN APPENDIX C
ARE RECORDED IN DEGREES FAHRENHEIT.





UNDERWRITERS LABORATORIES INC.

333 PFINGSTEN ROAD • NORTHBROOK, ILLINOIS 60062

an independent, not-for-profit organization testing for public safety

UNDERWRITERS LABORATORIES INC.

REPORT

on

FIRE TESTS CONDUCTED UNDER PURCHASE ORDER
NO. DTCG50-84-P-00968

by

Thomas Plens
and
Robert M. Berhinig

for

United States Department of Transportation
United States Coast Guard
Research and Development Center
Groton, CT

October 19, 1984

File USNC142
Project 84NK8504

C-2

Look For The  Listing or Classification Mark On The Product

N O T I C E

This Report was prepared as an account of work sponsored by the United States Government. Neither the United States Government nor Underwriters Laboratories Inc. nor any of their employees nor any of their contractors, subcontractors, or their employees make any warranty, express or implied, or assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or processes disclosed, or represents that its use would not infringe on privately owned rights. This Report may not be used in any way to infer or to indicate acceptability by Underwriters Laboratories Inc. for any product or system.

A B S T R A C T

Tests were conducted on twenty-one Class A-0 deck assemblies and twenty-one Class A-60 deck assemblies. Each test sample was a 36 by 36 in. by 3/16 in. thick steel plate with a penetrating item. Twenty-one penetrating items were submitted. Each penetrating item was installed through a Class A-0 deck assembly and through a Class A-60 deck assembly. The penetrating items included steel pipe, copper pipe, PVC pipe, steel duct and electrical cables.

All tests were conducted in accordance with Standard, "Fire Tests of Through Penetration Firestops," UL 1479 (ASTM E184). Forty-one samples were exposed to a 1 hour furnace fire that reached a temperature of 1000°F at 5 min, 1550°F at 30 min, and 1700°F at 60 min. Within 5 min after the fire exposure, forty samples were subjected to a water stream of 30 psi for a 13.5 sec duration.

During the tests, measurements and observations were made of the passage of flame and water through the deck assemblies, the temperature of assemblies, the temperature of the furnace, the pressure conditions within the furnace and the pressure of the water stream. Photographic records of forty-one tests were also obtained.

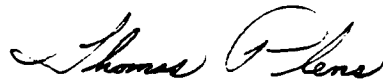
F O R E W O R D

This is a final report of an investigation conducted under Purchase Order No. DTCG50-84-P-00968 issued by the United States Department of Transportation, United States Coast Guard.

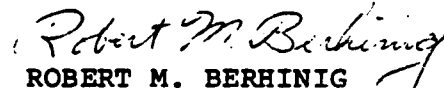
The test work was conducted during the time period of June, 1984 to July, 1984.

Respectfully submitted

UNDERWRITERS LABORATORIES INC.



THOMAS PLENS
Senior Laboratory Technician
Fire Protection Department



ROBERT M. BERHINIG
Associate Managing Engineer
Fire Protection Department

Reviewed and approved by:

/RMB

K. W. HOWELL
Associate Managing Engineer
Fire Protection Department

TP/RMB/KWH:br
lbry

I N T R O D U C T I O N

The tests were conducted to provide data to the United States Coast Guard (USCG) and the Canadian Coast Guard (CCG) in their joint study of firestop systems used to prevent the passage of flame and hot gases at penetrating items through Class A-0 and through Class A-60 deck assemblies.

Twenty-one combinations of firestop systems and penetrating items were tested. Each combination of firestop system and penetrating item was installed in a Class A-0 deck assembly and in a Class A-60 deck assembly. The penetrating items were positioned so that they extended 18 in. beyond the fire side of the steel plate of the deck assembly and extended 36 in. beyond the non-fire side of the deck assembly.

The Class A-0 deck assembly was 36 by 36 in. by 3/16 in. thick steel plate. The Class A-60 deck assembly was a 36 by 36 in. by 3/16 in. thick steel plate with rockwool insulation applied to the fire side of the steel plate and penetrating item.

All tests were conducted in accordance with the Standard, "Fire Tests of Through Penetration Firestops," UL 1479. This Standard is used to determine hourly ratings for firestop systems surrounding items penetrating through hourly rated fire resistive horizontal and vertical assemblies.

UL's small-scale horizontal furnace was used for all fire tests. This furnace has a horizontal opening of 31.5 by 31.5 in. with a depth of 32.5 in. A positive pressure differential was maintained between the furnace chamber and the laboratory.

The data package obtained during each test consisted of temperature measurements, photographic record and visual observations. Temperatures were recorded at 4 min intervals at various locations on each test sample. Photographs of most samples were obtained before the fire tests, at 5 min intervals during the fire tests, after the fire tests, during the water stream tests and after each water stream test. The appearance of each sample was observed during each fire test and after each water stream test.

The USCG and CCG selected and designed the penetrating items and firestop systems tested. The samples were delivered to UL with the penetrating items and firestop systems installed. The rockwool insulation was installed at UL.

The penetrating items included various combinations of steel pipe, copper pipe, PVC pipe, steel air ducts, and electrical cables. The firestop systems included steel plate, bronze plate and proprietary fire resistive sealants and devices.

C O N S T R U C T I O N O F T E S T A S S E M B L I E S

The construction details of the test assemblies were designed by the USCG and CCG. The samples were received at UL with the various penetrating items attached to the 36 in. by 36 in. by 3/16 in. thick steel plates. All samples were representative of an A-0 construction.

For samples representative of an A-60 construction, members of UL staff secured rockwool batts to the fire side of the steel plates and penetrating items. The rockwool batts were 63 mm and 75 mm thick and were Approved by the USCG as Class A-60 Structural Insulation as determined by the requirements of 46 CFR 164.007, "Specification for Structural Insulation".

The 63 mm thick batts were secured to the steel plate and the 75 mm thick batts were secured to the penetrating items. To secure the batts to the steel plates, 0.093 in. diameter steel pins were welded to the plates at a horizontal and vertical spacing of 12 in. The batts were impaled onto the pins and secured in place by means of clinch shields. The excess length of the steel pins was cut off. Steel pins were also attached to the steel penetrating items and the batts were affixed to the penetrating item. The batts surrounded the penetration for a distance of 15 in. as measured from the fire side of the steel plate. The remaining 3 in. of the penetrating item was left unprotected. The 75 mm thick batts were cut to provide a 75 mm thickness of protection to the penetrating item. A single layer of hexagonal wire netting was wrapped around the rockwool batts covering the steel penetrating item. The netting was formed by 0.041 in. diameter steel wire twisted into 2 in. hexagons. For the nonmetallic penetrating items, the batts were friction fitted and held in place by a single layer of hexagonal wire netting. The netting was formed into a basket shape with the top leg of the basket extending horizontally 3 in. The horizontal leg of the basket was secured to the plate and batt by means of steel pins and clinch shields. The excess length of the steel pins was removed after the clinch shields were installed.

T E S T R E C O R D - G E N E R A LFIRE EXPOSURE TEST:

The fire tests were conducted with the furnace temperatures controlled in accordance with the requirements of Standard, "Through-Penetration Firestops," UL 1479 (ASTM E814).

METHOD

The assemblies were tested on a horizontal furnace having a 31.5 in. by 31.5 in. opening. Details of the furnace are shown on ILL. 1. The furnace temperatures, measured 12 in. below the exposed surface of the test specimen, were adjusted to follow the Standard Time-Temperature Curve as specified in the Standard, UL 1479. These temperatures were measured by means of two thermocouples diametrically located at the quarter points.

Type K, 0.036 diameter chromel-alumel thermocouples were used for all temperature measurements on the deck assemblies. The thermocouples were covered with 2 in. by 2 in. by 7/16 in. thick dry ceramic fiber pads. The location of the thermocouples are as shown in ILLS. following each "Test Record."

The pressure differential between the furnace and the laboratory was measured with a probe connected to an electronic barometer. During the tests of Samples D-9/A0, D-9/A60, D-10/A0, D-10/A60, D-11/A60 and D-12/A60, the pressure probe was placed 0.25 in. below the exposed surface and was located as shown on ILL. 2. The furnace operation during these six fire tests was typical of the furnace operation for all forty-two fire tests.

RESULTS

Throughout the fire tests, observations were made of the character of the fire and its control, the conditions of the exposed and unexposed surfaces, and all developments pertaining to the performance of the penetrating items with special reference to integrity of the assembly and flame passage through the assembly.

The temperature measured on the test assemblies during each test are shown on ILLS. following each "Test Record."

The pressure measurements recorded during the tests of Samples D-9/A0, D-9/A60, D-10/A-0, D-10/A60, D-11/A60 and D-12/A60 are shown on ILLS. following their respective "Test Records." The pressure differential was 0.002 mm/Hg (0.26 PA) negative at the beginning of the fire tests. By 4 min into the fire test, the pressure differential was 0.002 mm/Hg (0.26 PA) positive and gradually increased to a maximum positive pressure differential of 0.027 mm/Hg (3.60 PA) when the test was terminated at 60 min.

HOSE STREAM TEST:

SAMPLE

The hose (water) stream was applied to the exposed surface of the deck assembly. Immediately following the fire exposure test, the sample was removed from the furnace and placed in a steel support rack which pivoted the sample approximately 90° such that the exposed and unexposed surfaces of the sample, as fire tested, were orientated vertically like a wall assembly. The hose stream test commenced approximately 4 min after the furnace fire was extinguished.

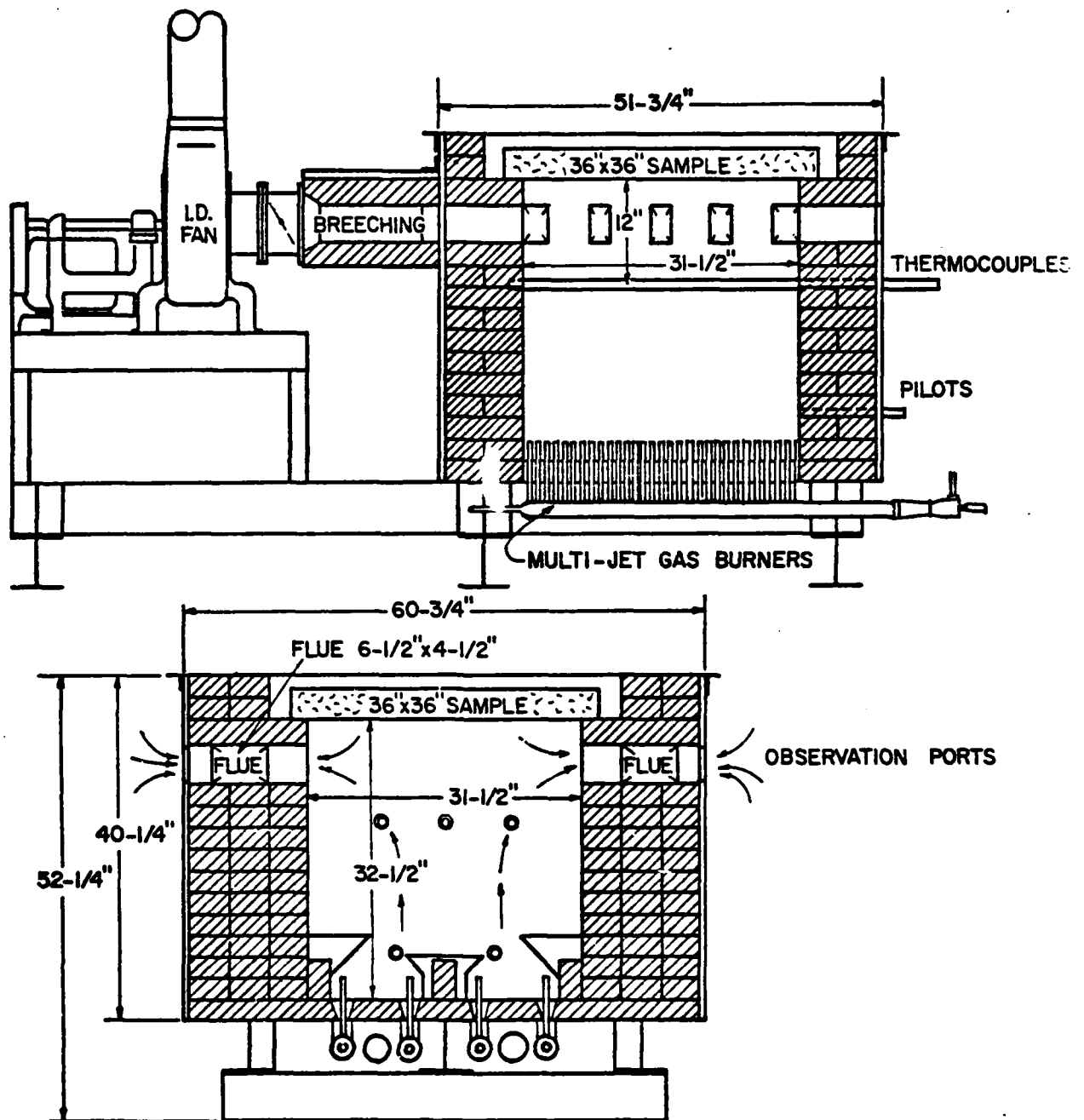
METHOD

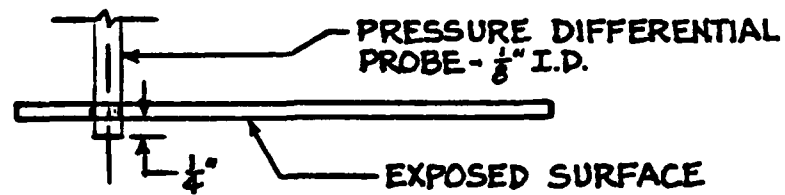
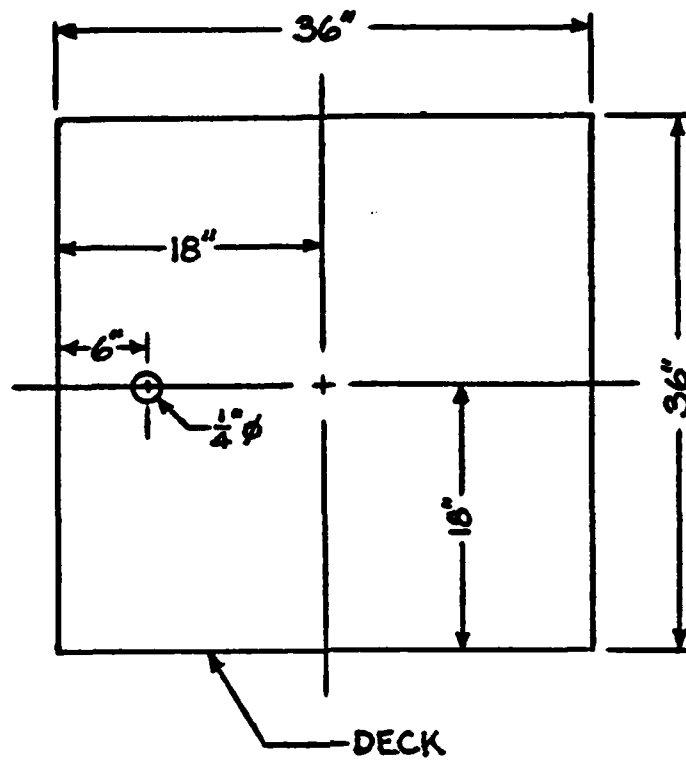
The hose (water) stream test was conducted in accordance with the Standard, "Through-Penetration Firestops," UL 1479 (ASTM E814). After the 1 h fire exposure, the assemblies were subjected to the action of a 30 psi water stream applied for a duration of 1.5 s/ft² of exposed area. The water stream was applied with a 1-1/8 in. diameter nozzle at a perpendicular distance of 20 ft from the center of the test assembly. The water stream was applied to the 9 ft² samples for 13.5 s and traversed the deck assembly and penetrating item.

RESULTS

No through projection of water was noted on the unexposed surfaces of the various deck assemblies.

SMALL SCALE HORIZONTAL EXPOSURE FURNACE





PRESSURE DIFFERENTIAL PROBE LOCATIONS

T E S T R E C O R D D1/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D1/A0 and as shown in ILL. 3.

The fire and hose stream tests were conducted on June 4, 1984.

RESULTS

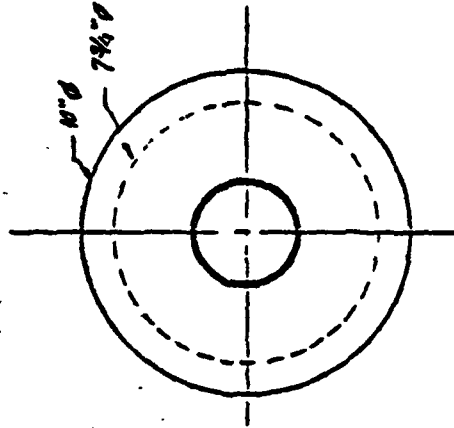
Observations During Fire Test - By 45 min, the unexposed surface of the deck was glowing red.

No significant changes occurred during the remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature of the Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 4.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 5 through 5B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



JUNE 4, 1984

(steel wire)

- ① 3041634 STEEL PROF. ALMA A53 GRADE A AND
- ② STEEL PIPE 3/4" THK ALMA-A53 GRADE A AND

FILE:	NOTE:
DECK	DEPT OF
RENEGADE	INTERIOR DEPT
	7/5
	FILE:
	1

SAMPLE D-1/AO
TEST DATE JUNE 4, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On unexposed surface, equidistant from penetrant and firestop periphery.
3	On unexposed surface, equidistant from penetrant and firestop periphery.
4	On unexposed surface, equidistant from penetrant and firestop periphery.
5	On unexposed surface, periphery of firestop.
6	On penetrant, 1 in. above unexposed surface.
7	On unexposed surface, 12 in. from periphery of opening.
8	On unexposed surface, 12 in. from periphery of opening.
9	On unexposed surface, periphery of opening.

USNC142
ILL. 4

US COAST GUARD D1/A0

6-4-84

UNEXPOSED SURFACE

- THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

4	192.1	314.3	78.2	336.5
8	389.7	662.6	80.2	735.6
12	607.5	911.8	83.5	969.0
16	738.4	1041.8	87.3	1089.3
20	818.1	1101.0	92.2	1147.7
24	869.2	1139.0	97.9	1194.1
28	905.6	1171.3	102.7	1228.1
32	933.8	1204.1	114.2	1258.9
36	960.2	1235.9	121.9	1291.4
40	982.7	1261.6	127.7	1315.9
44	1002.6	1287.3	108.6	1340.1
48	1018.0	1304.0	109.8	1361.8
52	1028.2	1313.1	110.2	1369.8
56	1033.9	1321.8	113.0	1381.3
60	1041.2	1331.0	117.8	1389.7

US COAST GUARD D1/A0
6-4-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
4	324.5	361.5	277.8	306.4
8	683.4	807.4	561.2	659.7
12	933.1	1030.1	760.2	886.5
16	1065.7	1134.6	887.3	1010.4
20	1112.4	1179.9	954.3	1070.9
24	1148.8	1227.9	1009.5	1113.9
28	1182.2	1265.1	1049.8	1150.2
32	1216.0	1294.6	1085.1	1180.2
36	1248.9	1324.0	1117.7	1213.3
40	1278.1	1348.3	1146.6	1242.0
44	1303.6	1373.2	1171.7	1270.2
48	1319.7	1389.3	1191.7	1290.9
52	1328.0	1393.7	1200.7	1302.4
56	1334.7	1404.7	1210.4	1314.5
60	1342.4	1410.7	1220.9	1323.0

US COAST GUARD D1/A0
6-4-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

9

TIME
(MIN'S)

4	335.3
8	724.1
12	954.5
16	1073.6
20	1127.1
24	1164.0
28	1196.5
32	1226.6
36	1258.4
40	1287.4
44	1312.3
48	1327.3
52	1337.0
56	1345.1
60	1354.2

T E S T R E C O R D D1/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D1/A60 and as shown in ILL. 6.

The fire and hose stream tests were conducted on July 6, 1984.

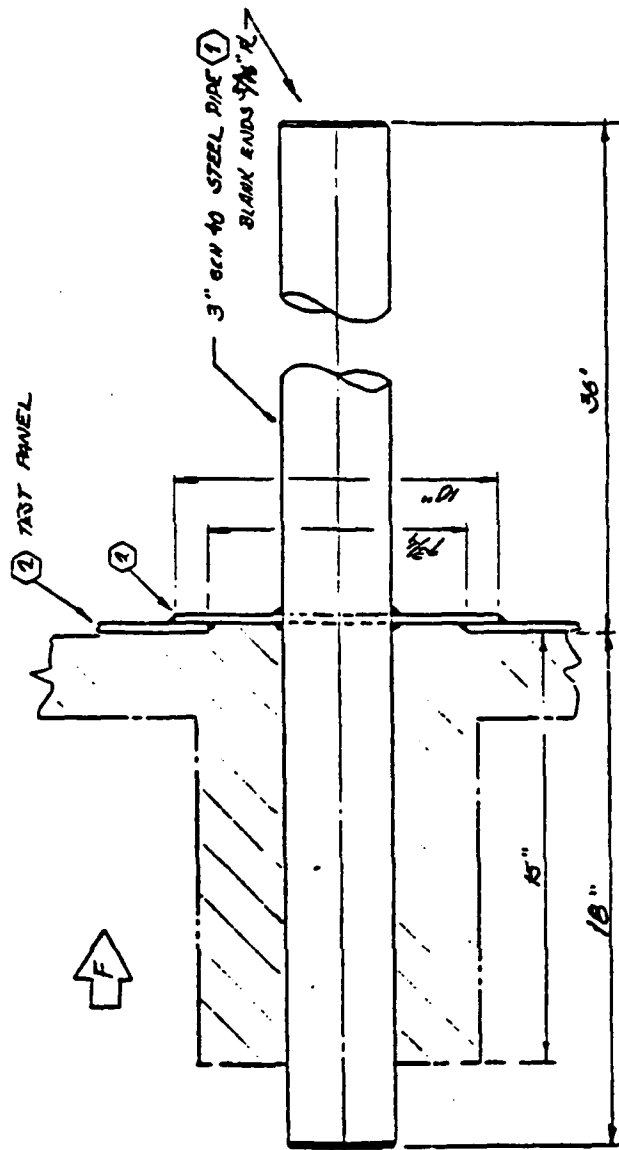
RESULTS

Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 7.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 8 through 8C.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-1/A60

JULY 6, 1984

PENETRATION NO D-1

(STEEL PIPE)

① SEAMLESS STEEL PIPE, ASTM A53 GRADE A AND

② STEEL PLATE 3/8" THK ASTM A53 GRADE A AND B

TYPE:	DECK
NO.:	7/8
DATE:	—

SAMPLE D-1/A60
TEST DATE JULY 6, 1984

<u>T.C.</u>	<u>Location</u>
1	On unexposed surface, equidistant from penetrant and firestop periphery.
2	On unexposed surface, equidistant from penetrant and firestop periphery.
3	On unexposed surface, equidistant from penetrant and firestop periphery.
4	On unexposed surface, periphery of firestop.
5	On unexposed surface, 1 in. from periphery of firestop.
6	On penetrant, 1 in. above unexposed surface.
7	On unexposed surface, 12 in. from periphery of opening.
8	On unexposed surface, 12 in. from periphery of opening.
9	On unexposed surface, periphery of opening.
10	On penetrant, 6 in. above unexposed surface.
11	On penetrant, 12 in. above unexposed surface.
12	On penetrant, 18 in. above unexposed surface.
13	On penetrant, 24 in. above unexposed surface.

USNC142
ILL. 7

US COAST GUARD D1/A60
7-6-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	1	2	3	4
TIME (MIN'S)				
0	81.3	81.3	80.7	81.2
4	81.3	81.5	81.8	81.3
8	82.4	82.0	84.9	82.6
12	85.3	86.5	90.0	85.4
16	90.5	92.7	99.5	90.9
20	98.1	101.7	113.0	99.1
24	110.4	115.9	129.7	111.9
28	126.4	133.1	148.1	127.1
32	143.9	151.4	168.2	142.2
36	162.8	173.5	192.0	158.5
40	185.2	197.9	216.3	178.4
44	207.1	221.4	239.8	196.9
48	227.9	245.3	262.3	214.0
52	247.8	265.7	284.1	231.1
56	266.1	284.5	303.8	244.3
60	283.2	301.4	321.5	257.0

US COAST GUARD D1/A60
7-6-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	80.8	80.4	81.1	80.8
4	81.9	80.0	81.7	81.4
8	85.4	82.8	84.2	83.4
12	91.7	86.0	88.4	86.7
16	101.8	93.4	95.8	92.8
20	117.5	101.6	108.9	101.9
24	134.6	114.5	123.9	115.0
28	150.9	131.5	138.2	129.5
32	169.9	150.9	151.2	143.5
36	189.3	171.7	165.8	160.5
40	208.8	195.3	179.9	176.5
44	227.5	218.7	193.0	192.5
48	245.1	241.4	205.0	206.3
52	261.9	262.8	216.0	219.1
56	277.4	283.8	225.7	230.1
60	291.3	302.3	234.7	240.1

US COAST GUARD D1/A60
7-6-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
0	80.6	80.4	80.5	80.6
4	81.1	80.8	80.8	80.8
8	82.6	81.0	81.5	81.3
12	85.8	84.3	82.9	82.3
16	91.5	87.7	84.7	83.4
20	99.7	91.0	86.9	84.8
24	112.5	96.5	89.7	86.5
28	127.8	103.7	92.0	88.5
32	143.2	112.5	95.9	90.8
36	160.9	122.0	100.3	93.3
40	181.5	133.4	105.6	95.0
44	201.1	145.5	111.3	98.0
48	219.8	157.8	117.0	101.3
52	237.6	169.8	123.2	104.8
56	253.7	181.1	129.2	108.1
60	268.4	192.3	135.3	111.7

US COAST GUARD D1/A60
7-6-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

13

TIME
(MIN'S)

0	80.7
4	80.0
8	81.6
12	82.3
16	83.4
20	84.4
24	85.6
28	87.1
32	88.7
36	90.4
40	91.0
44	93.9
48	94.9
52	97.1
56	99.2
60	101.5

T E S T R E C O R D D2/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D2/A0 and as shown in ILL. 9.

The fire and hose stream tests were conducted on June 4, 1984.

RESULTS

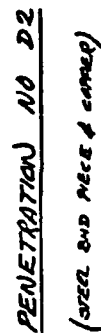
Observations During Fire Tests - By 35 min, the unexposed surface of the deck was glowing red.

No significant changes occurred during the remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 10.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 11 through 11C.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



- ① STEEL PLATE 3/8" THK, ASTM-A53 GRADE-A 40
- ② SEAMLESS STEEL PIPE, ASTM A-53 GRADE A 40 3" SCH 40
- ③ CORROD PIPE 3". PERMAN, ASTM B-92

C-27

SAMPLE D-2/AO
TEST DATE JUNE 4, 1984

<u>T.C.</u>	<u>Location</u>
1	On unexposed surface, equidistant from penetrant and firestop periphery.
2	On unexposed surface, equidistant from penetrant and firestop periphery.
3	On unexposed surface, equidistant from penetrant and firestop periphery.
4	On unexposed surface, equidistant from penetrant and firestop periphery.
5	On unexposed surface, 1 in. from penetrant.
6	On unexposed surface, 1 in. from penetrant.
7	On unexposed surface, 12 in. from periphery of opening.
8	On unexposed surface, 12 in. from periphery of opening.
9	On penetrant, 1 in. above unexposed surface.
10	On penetrant, 6 in. above unexposed surface.
11	On penetrant, 12 in. above unexposed surface.
12	On penetrant, 18 in. above unexposed surface.
13	On penetrant, 24 in. above unexposed surface.

USNC142
ILL. 10

US COAST GUARD D1/A0 TEST 2
6-4-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	1	2	3	4
TIME (MIN'S)				
0	86.7	90.5	89.9	90.4
4	174.5	270.0	304.0	319.2
8	346.5	553.1	621.1	646.5
12	529.2	795.3	858.0	883.0
16	666.0	941.3	978.1	994.9
20	754.1	1023.3	1047.1	1064.0
24	816.2	1078.0	1092.0	1109.9
28	857.6	1119.4	1126.2	1144.2
32	890.2	1158.6	1162.6	1181.2
36	921.4	1190.2	1197.0	1217.1
40	945.4	1218.8	1226.4	1247.9
44	968.3	1247.9	1255.7	1277.0
48	991.5	1273.5	1281.5	1303.0
52	1011.2	1294.6	1303.6	1328.4
56	1025.7	1309.8	1316.1	1342.2
60	1042.1	1326.4	1334.4	1369.2

US COAST GUARD ILL/AO TEST 2
6-4-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	89.0	92.2	93.1	90.9
4	233.2	391.8	302.5	323.4
8	516.4	802.1	574.7	646.0
12	790.9	1004.5	772.0	856.3
16	918.5	1076.4	894.6	956.6
20	987.7	1135.2	969.8	1031.3
24	1035.3	1170.6	1030.4	1084.3
28	1076.9	1200.1	1064.4	1116.5
32	1119.2	1238.5	1101.9	1151.3
36	1157.2	1275.2	1137.3	1187.6
40	1188.7	1304.7	1166.7	1218.2
44	1218.9	1332.8	1195.6	1249.0
48	1245.5	1357.2	1218.7	1274.1
52	1264.4	1387.8	1238.2	1305.3
56	1279.7	1394.7	1260.6	1315.3
60	1296.9	1425.0	1273.0	1338.1

US COAST GUARD D1/A0 TEST 2
6-4-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
0	90.8	84.4	83.6	83.3
4	290.9	97.2	88.9	84.2
8	578.7	151.4	106.0	87.2
12	809.4	244.8	139.8	93.1
16	937.5	344.9	180.0	104.2
20	1014.0	426.6	218.7	118.7
24	1066.8	489.8	252.8	135.5
28	1103.0	536.7	283.9	153.9
32	1139.1	572.2	311.3	172.5
36	1170.8	600.8	337.0	191.3
40	1199.1	623.5	362.0	210.0
44	1227.6	643.5	379.4	226.8
48	1254.0	663.7	401.7	244.8
52	1280.3	681.0	423.6	262.2
56	1294.7	696.9	440.1	278.3
60	1316.4	711.6	456.7	293.6

US COAST GUARD D3/A0 TEST 2
6-4-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

13

TIME
(MIN'S)

0	83.4
4	84.3
8	87.3
12	93.1
16	100.2
20	110.2
24	122.4
28	136.0
32	149.7
36	163.6
40	178.2
44	190.8
48	204.7
52	219.1
56	232.1
60	245.0

T E S T R E C O R D D2/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D2/A60 and as shown in ILL. 12.

The fire and hose stream tests were conducted on July 17, 1984.

RESULTS

Observations During Fire Tests - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 13.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 14 through 14C.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.

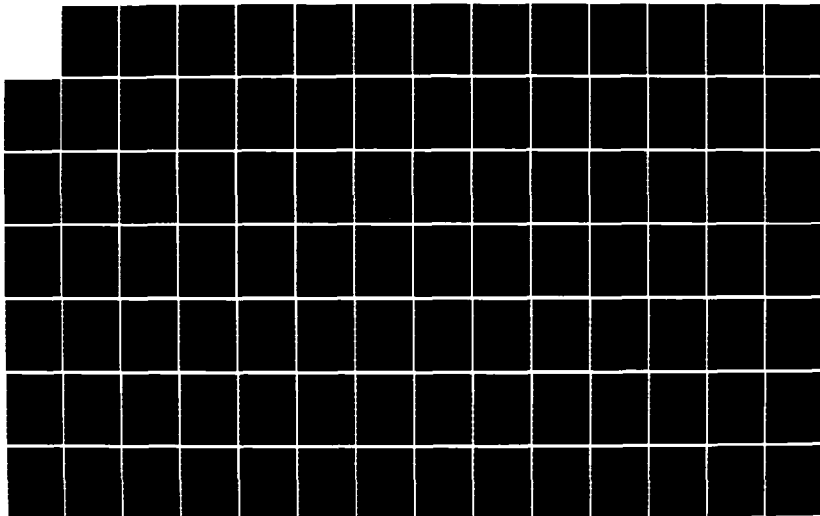
AD-A163 315

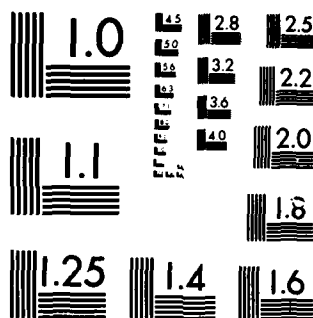
FIRE RESISTANCE TESTING OF BULKHEAD AND DECK
PENETRATIONS(U) COAST GUARD RESEARCH AND DEVELOPMENT
CENTER GROTON CT D E BEENE ET AL. OCT 85 CGR/DC-5/85
UNCLASSIFIED USCG-D-33-85

2/4

F/G 13/12

NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

SAMPLE D-2/A60
TEST DATE JULY 17, 1984

<u>T.C.</u>	<u>Location</u>
1	On unexposed surface, equidistant from penetrant and firestop periphery.
2	On unexposed surface, equidistant from penetrant and firestop periphery.
3	On unexposed surface, equidistant from penetrant and firestop periphery.
4	On unexposed surface, equidistant from penetrant and firestop periphery.
5	On unexposed surface, 1 in. from penetrant.
6	On unexposed surface, 1 in. from penetrant.
7	On unexposed surface, 12 in. from periphery of opening.
8	On unexposed surface, 12 in. from periphery of opening.
9	On penetrant, 1 in. above unexposed surface.
10	On penetrant, 6 in. above unexposed surface.
11	On penetrant, 12 in. above unexposed surface.
12	On penetrant, 18 in. above unexposed surface.
13	On penetrant, 24 in. above unexposed surface.

USNC142
ILL. 13

US COAST GUARD D2/A60
7- -84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	1	2	3	4
TIME (MIN'S)				
4	78.4	78.2	78.2	78.5
8	79.7	79.3	79.1	79.0
12	82.2	81.7	81.2	83.2
16	86.8	85.7	84.9	89.1
20	93.6	92.7	91.3	97.5
24	104.8	101.9	100.1	110.3
28	118.9	115.9	113.6	125.9
32	134.1	132.0	127.9	141.6
36	148.9	148.1	144.7	157.7
40	167.3	164.7	160.3	177.2
44	187.0	186.5	181.7	198.0
48	205.9	206.9	199.9	217.6
52	224.3	226.6	218.0	236.7
56	241.8	245.0	233.0	254.4
60	257.9	262.1	249.3	271.5

US COAST GUARD D2/A60
7- -84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

5

6

7

8

TIME
(MIN'S)

4	78.6	78.7	78.5	78.6
8	80.3	80.6	80.1	79.0
12	83.3	83.8	83.1	82.5
16	88.8	89.9	88.6	86.6
20	97.2	98.6	97.5	93.1
24	110.4	111.6	111.8	103.8
28	125.9	125.8	127.7	116.3
32	141.1	139.4	142.0	128.8
36	156.3	154.6	156.5	139.9
40	173.5	170.6	171.0	152.4
44	190.9	186.2	183.9	164.5
48	207.0	201.3	196.4	184.4
52	222.4	215.9	208.0	198.4
56	236.6	229.7	218.5	208.5
60	249.6	242.1	227.8	219.1

US COAST GUARD D2/A60
7- -84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
4	78.2	77.0	77.8	77.6
8	79.1	78.6	78.1	77.0
12	80.9	79.6	78.7	78.3
16	84.4	81.4	79.6	78.8
20	89.8	84.1	80.8	79.7
24	96.4	87.9	82.4	80.6
28	108.2	93.4	84.3	81.4
32	123.0	98.6	86.6	82.6
36	140.2	106.3	88.0	83.0
40	159.2	115.5	92.4	85.6
44	180.6	125.6	94.5	87.2
48	202.7	136.2	97.8	89.1
52	225.1	148.2	101.6	90.7
56	246.3	159.1	105.8	92.7
60	266.1	169.5	109.6	93.0

US COAST GUARD D2/A60
7- -84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

13

TIME
(MIN'S)

4	77.6
8	77.8
12	78.1
16	78.6
20	79.4
24	80.3
28	81.2
32	82.3
36	83.4
40	85.1
44	86.9
48	88.4
52	89.8
56	91.8
60	93.3

T E S T R E C O R D D3/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D3/A0 and as shown in ILL. 15.

The fire and hose stream tests were conducted on June 8, 1984.

RESULTS

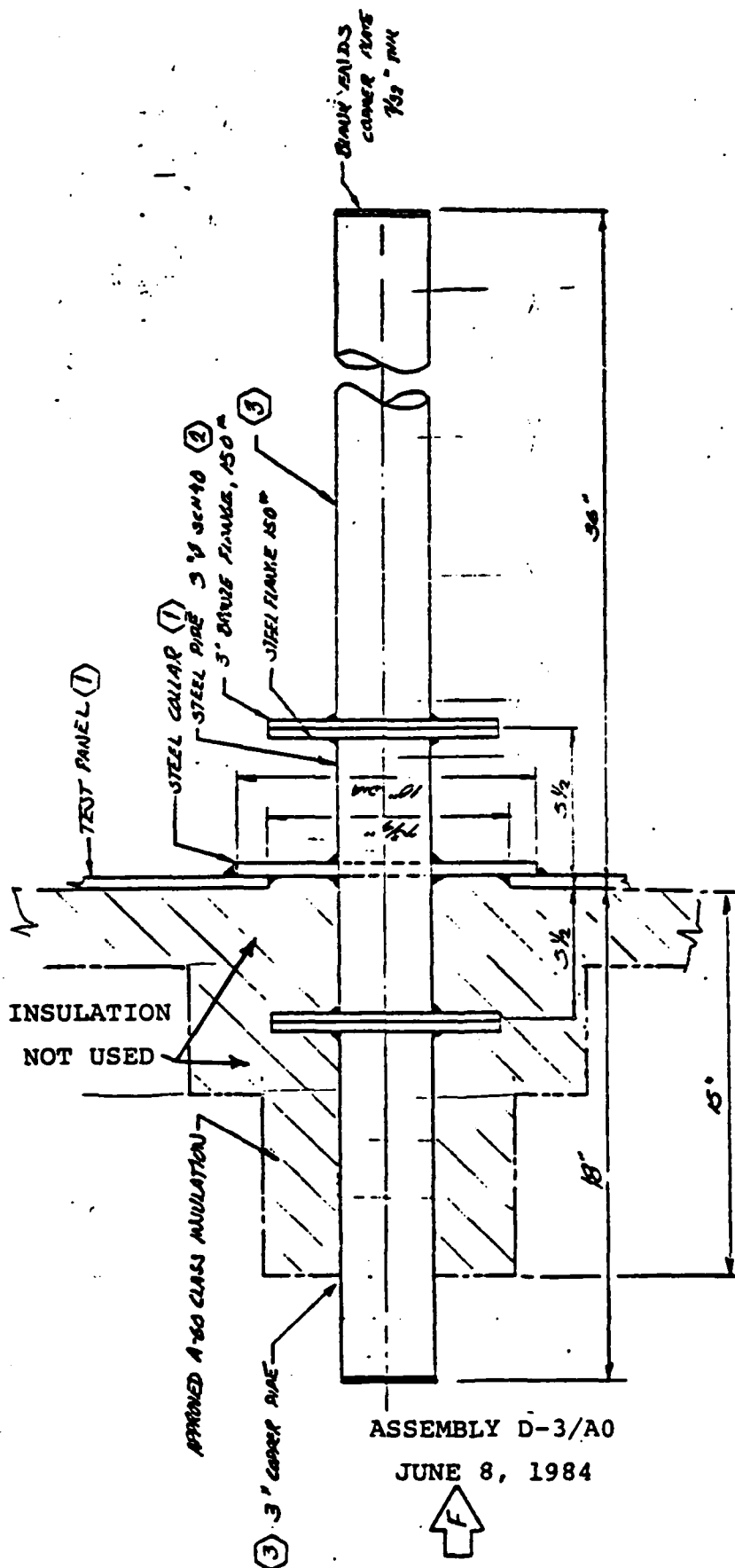
Observations During Fire Test - By 45 min, the unexposed surface of the deck was glowing red.

No significant changes occurred during the remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 16.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 17 through 17C.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-3/A0

JUNE 8, 1984



C-41

PENETRATION NO D-3

(STEEL SPACER & COLLAR PIPE)

- ① STEEL PIPE 3/16" THK, ASTM A53 GRADE A M18
- ② SEAMLESS STEEL PIPE, 3" SCH 40
ASTM A53 GRADE A M18
- ③ 3" SQUARE, COLLAR PIPE ASTM A-42

TITLE:	DECK
DATE:	NOV 84
DESIGNED BY:	7/8
SCALE:	1" = 1'-0"
REV:	
FIG. NO.:	D-3

PENETRATION

SAMPLE D-3/AO
TEST DATE JUNE 8, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 4-1/2 in. above unexposed surface.
3	On penetrant, 6-1/2 in. above unexposed surface.
4	On penetrant, 12 in. above unexposed surface.
5	On penetrant, 18 in. above unexposed surface.
6	On penetrant, 24 in. above unexposed surface.
7	On unexposed surface, at interface of penetrant and unexposed surface.
8	On unexposed surface, equidistant from penetrant and firestop periphery.
9	On unexposed surface, equidistant from penetrant and firestop periphery.
10	On unexposed surface, equidistant from penetrant and firestop periphery.
11	On unexposed surface, at periphery of opening.
12	On unexposed surface, at periphery of firestop.
13	On unexposed surface, 1 in. from periphery of firestop.
14	On unexposed surface, 12 in. from periphery of opening.
15	On unexposed surface, 12 in. from periphery of opening.
16	On penetrant, at interface of bronze flange and penetrant.

USNC142
ILL. 16

US COAST GUARD D3/A0
6-8-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	91.7	87.5	83.7	83.8
4	181.9	126.2	86.8	88.6
8	333.2	212.5	95.9	101.0
12	486.2	315.4	117.6	123.9
16	629.9	409.9	151.3	154.5
20	716.6	489.3	189.8	187.4
24	781.1	555.0	230.1	221.2
28	834.0	601.2	271.0	255.1
32	878.5	636.7	308.6	287.1
36	920.8	682.0	346.5	319.6
40	955.9	717.3	380.3	347.2
44	983.2	749.6	413.1	375.8
48	1007.9	776.6	444.1	401.9
52	1030.8	800.5	469.9	423.5
56	1053.3	826.6	497.9	448.7
60	1076.3	852.5	522.3	471.0

US COAST GUARD D3/A0
6-8-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

5

6

7

8

TIME
(MIN'S)

0	83.9	83.7	93.2	97.6
4	87.5	85.4	234.0	295.6
8	96.5	90.2	407.6	587.0
12	113.0	98.3	631.5	815.2
16	133.7	111.6	813.1	960.2
20	156.2	126.7	909.8	1045.0
24	179.1	144.3	979.4	1097.6
28	203.0	163.3	1038.2	1149.2
32	226.2	182.0	1088.1	1197.8
36	250.2	201.5	1129.7	1235.9
40	270.5	219.1	1163.9	1266.9
44	292.7	237.5	1183.9	1289.7
48	312.9	255.2	1204.2	1305.6
52	329.9	272.5	1228.9	1326.6
56	349.4	288.5	1252.7	1353.1
60	366.6	303.0	1274.6	1375.2

US COAST GUARD D3/A0
6-8-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

9

10

11

12

TIME
(MIN'S)

0	95.4	96.0	97.9	102.1
4	323.9	297.8	299.0	361.2
8	653.6	617.8	575.5	709.2
12	790.3	838.6	797.9	928.4
16	875.2	985.1	939.2	1051.9
20	934.6	1049.3	1021.0	1107.7
24	934.1	1099.1	1077.6	1145.2
28	995.2	1147.3	1128.0	1191.4
32	1021.1	1191.3	1174.6	1237.7
36	1046.4	1224.5	1211.4	1270.8
40	1055.9	1254.0	1244.1	1297.2
44	1078.3	1274.4	1266.4	1315.9
48	1080.7	1291.8	1287.6	1332.4
52	1107.3	1311.2	1309.1	1353.8
56	1135.7	1335.1	1330.7	1378.6
60	1144.1	1357.4	1354.4	1417.4

US COAST GUARD D3/A0
6-8-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	13	14	15	16
TIME (MIN'S)				
0	88.2	107.6	99.7	83.7
4	93.5	369.5	290.6	85.0
8	101.1	677.3	604.5	94.6
12	104.3	871.1	807.2	117.3
16	110.9	983.6	910.6	152.8
20	115.3	1041.3	976.2	194.8
24	120.4	1080.9	1025.1	239.0
28	128.7	1122.4	1066.7	283.3
32	133.0	1166.1	1109.9	325.5
36	136.4	1198.7	1143.0	367.5
40	148.7	1230.8	1170.7	406.0
44	150.7	1249.9	1187.2	441.5
48	157.6	1271.9	1206.8	474.6
52	154.7	1299.8	1234.6	502.8
56	163.0	1329.3	1258.6	530.9
60	162.2	1355.1	1280.8	557.2

T E S T R E C O R D D3/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D3/A60 and as shown on ILL. 18.

The fire and hose stream tests were conducted on July 16, 1984.

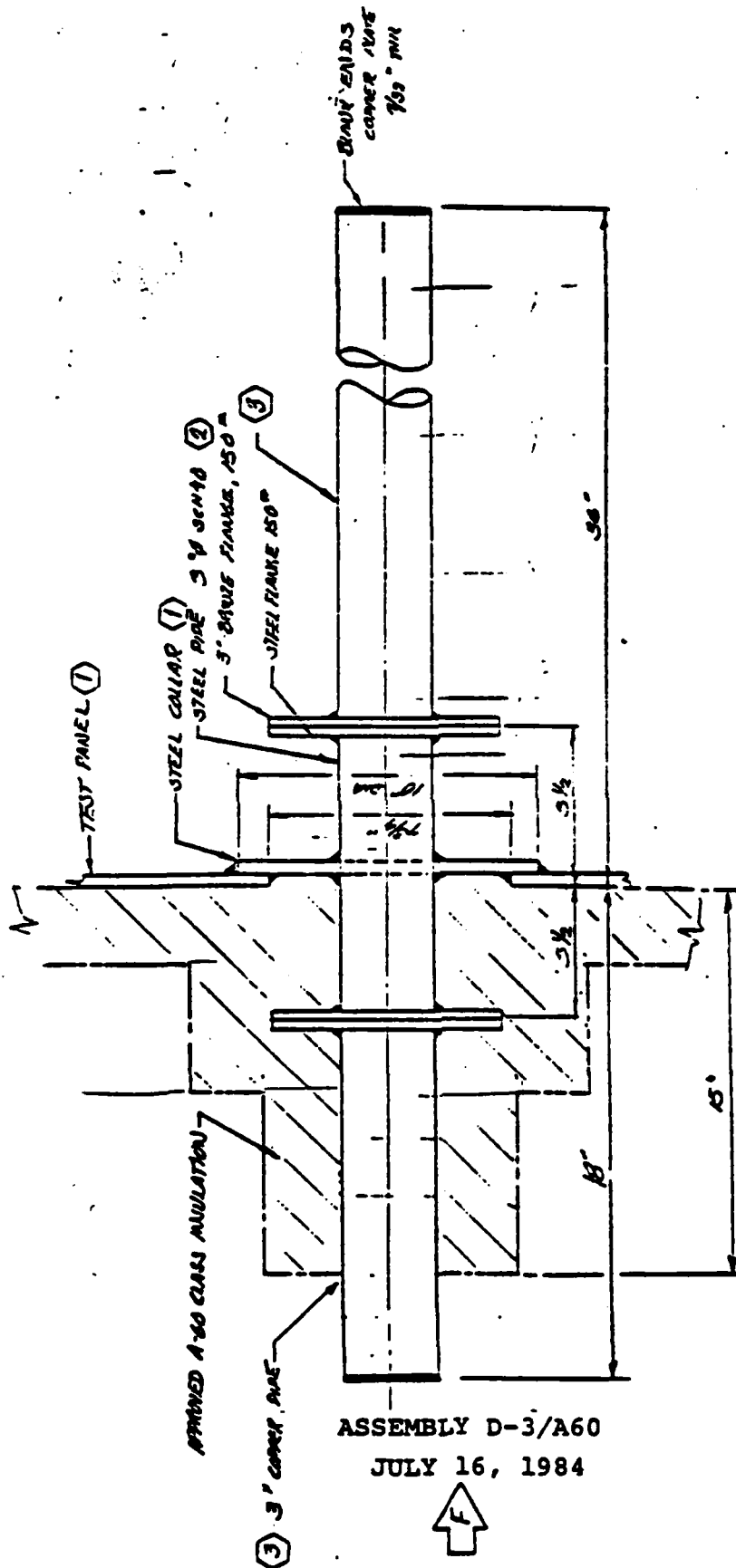
RESULTS

Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 19.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 20 through 20C.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



PENETRATION NO D-3

(STEEL SPOT & CORNER PLATE)

- (1) STEEL PIPE 3/8" THK, ASTM A53 GRADE A AND B
- (2) SEAMLESS STEEL PIPE, 3" SCH 40 ASTM A-53 GRADE A AND B
- (3) 3" REMAIN, CORNER PLATE ASTM A-36

DATE:	NOV 89
BY:	7/8
SCALE:	1/4"
FIG. NO.:	D-3
TITLE:	DECK PENETRATION

SAMPLE D-3/A60
TEST DATE JULY 16, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 4-1/2 in. above unexposed surface.
3	On penetrant, 6-1/2 in. above unexposed surface.
4	On penetrant, 12 in. above unexposed surface.
5	On penetrant, 18 in. above unexposed surface.
6	On penetrant, 24 in. above unexposed surface.
7	On unexposed surface, at interface of penetrant and unexposed surface.
8	On unexposed surface, equidistant from penetrant and firestop periphery.
9	On unexposed surface, equidistant from penetrant and firestop periphery.
10	On unexposed surface, equidistant from penetrant and firestop periphery.
11	On unexposed surface at periphery of opening.
12	On unexposed surface, at periphery of firestop.
13	On unexposed surface, 1 in. from periphery of firestop.
14	On unexposed surface, 12 in. from periphery of opening.
15	On unexposed surface, 12 in. from periphery of opening.

USNC142
ILL 19

US COAST GUARD D3/A60
7-16-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	79.0	79.9	79.8	79.0
4	80.6	80.4	80.1	80.3
8	81.7	81.1	80.5	80.6
12	83.9	82.5	80.0	81.2
16	87.8	84.6	81.7	81.0
20	93.4	87.9	82.8	83.1
24	99.7	91.0	84.1	84.4
28	108.4	96.1	85.9	86.2
32	118.5	102.3	87.9	87.0
36	130.1	109.2	90.4	90.4
40	141.3	116.4	93.2	92.9
44	153.5	124.2	95.4	94.8
48	166.0	132.1	98.9	97.9
52	179.0	139.9	103.2	101.8
56	192.8	150.2	107.5	105.6
60	204.2	159.1	111.8	109.5

US COAST GUARD D3/A60
7-16-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	80.1	80.2	80.2	80.7
4	80.3	80.4	80.6	80.7
8	80.6	80.7	81.9	81.5
12	81.1	81.2	85.1	83.4
16	81.8	81.7	90.9	87.2
20	82.8	82.6	98.2	93.3
24	83.0	83.6	109.6	101.2
28	85.4	84.0	123.6	112.3
32	86.9	86.2	139.1	124.9
36	88.7	87.6	155.6	138.0
40	90.7	89.1	172.3	151.3
44	92.9	90.9	189.6	166.2
48	94.3	92.9	207.4	181.3
52	97.4	94.6	226.6	196.4
56	100.5	96.6	244.5	210.9
60	103.3	99.0	260.4	224.8

US COAST GUARD D3/A60
7-16-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
0	80.8	80.9	80.6	80.9
4	80.9	80.9	80.8	80.9
8	81.8	81.8	81.6	81.8
12	84.1	84.1	83.7	83.8
16	88.4	87.0	87.2	87.1
20	94.2	93.4	93.3	92.0
24	103.9	102.4	101.0	100.7
28	116.0	113.9	112.4	111.8
32	129.2	126.7	124.9	123.3
36	143.1	140.2	138.2	135.1
40	157.4	154.2	151.0	147.3
44	173.2	169.4	165.7	162.1
48	189.4	185.3	180.8	175.7
52	205.7	200.9	195.8	190.4
56	221.1	216.6	210.3	203.3
60	235.8	231.7	224.1	215.6

US COAST GUARD D3/A60
7-16-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	13	14	15
TIME (MIN'S)			
0	80.9	80.6	80.8
4	81.2	81.5	81.3
8	82.9	84.2	83.4
12	85.7	89.0	86.0
16	90.8	100.5	93.2
20	98.1	116.2	105.5
24	109.4	131.4	119.4
28	121.9	143.8	132.7
32	133.4	158.3	144.9
36	146.3	173.0	159.7
40	160.2	186.8	173.8
44	173.9	199.9	187.2
48	187.0	212.0	199.6
52	199.5	224.1	210.9
56	211.7	234.9	222.2
60	222.6	244.7	232.4

T E S T R E C O R D D4/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D4/A0 and as shown in ILL. 21.

The fire and hose stream tests were conducted on June 8, 1984.

RESULTS

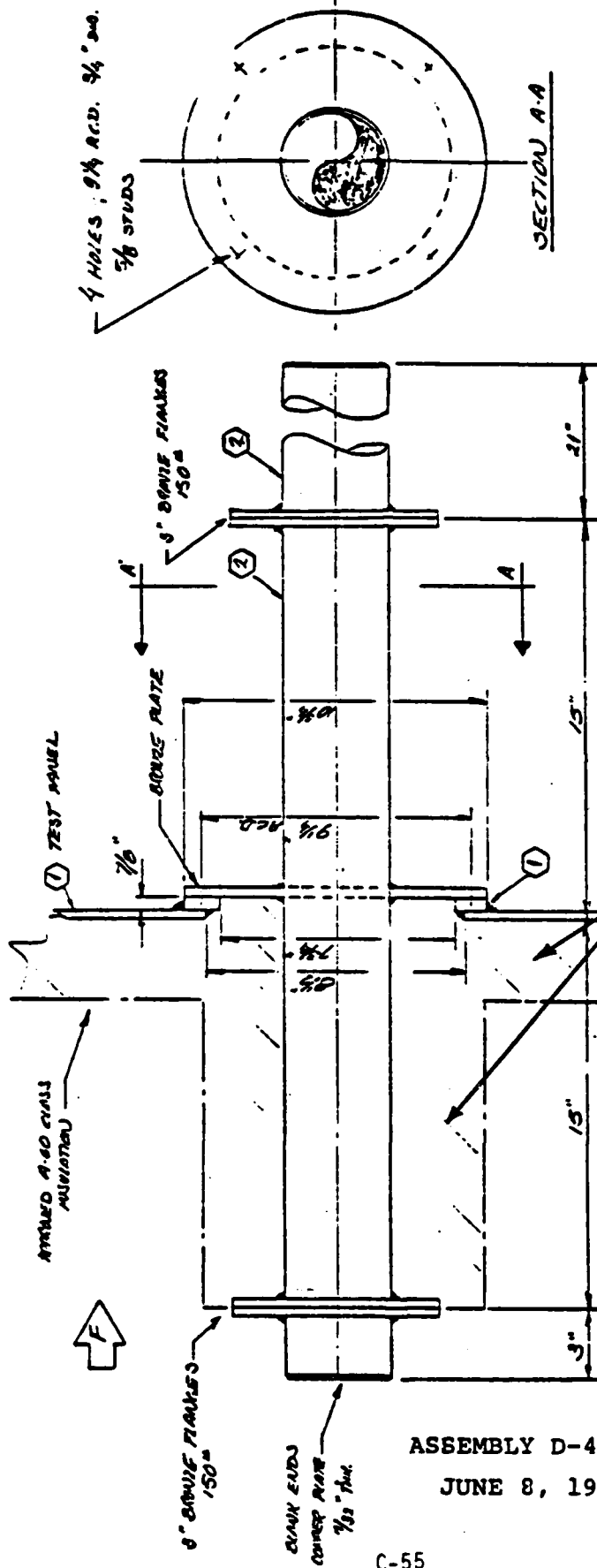
Observations During Fire Tests - By 18 min, the 3 in. bronze flange, on the exposed side of the assembly, had separated from the copper pipe and fell into the furnace chamber. By 45 min, the unexposed surface of the deck was glowing red.

No significant changes occurred during remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 22.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 23 through 23B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



PENETRATION NO D-4
(CORNER)

INSULATION
NOT USED

- ① STEEL PLATE 3/4" THK, ASTM A53 GRADE A & B
- ② 3" SQUARE, CORNER RAS ASTM B-42

TITLE:	DECK PENETRATION
DATE:	NOV 21, 1984
SCALE:	1" = 1'
REV:	D-4

C-55

SAMPLE D-4/AO
TEST DATE JUNE 8, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 15 in. above unexposed surface.
4	On penetrant, 17 in. above unexposed surface.
5	On penetrant, 24 in. above unexposed surface.
6	On unexposed surface, 1 in. from penetrant.
7	On unexposed surface, 1 in. from penetrant.
8	On unexposed surface, at periphery of opening.
9	On unexposed surface, at periphery of firestop.
10	On unexposed surface, 1 in. from periphery of firestop.
11	On unexposed surface, 12 in. from edge of opening.
12	On unexposed surface, 12 in. from edge of opening.

USNC142
ILL. 22

US COAST GUARD D4/A0
6-8-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

TIME
(MIN'S)

	1	2	3	4
0	81.7	81.3	80.0	81.8
4	174.2	117.0	93.1	82.7
8	311.3	185.2	125.2	87.3
12	474.8	286.9	178.5	98.0
16	637.5	392.0	239.8	117.2
20	763.1	478.3	296.9	142.4
24	851.9	549.0	349.3	172.8
28	915.7	604.6	394.9	204.7
32	958.8	644.8	433.5	236.2
36	990.9	674.9	465.0	265.3
40	1021.5	705.8	494.0	292.4
44	1044.8	737.6	521.9	318.9
48	1061.7	762.8	541.3	340.8
52	1077.3	762.7	563.4	363.9
56	1088.6	777.0	581.0	382.5
60	1098.8	788.0	596.1	399.3

US COAST GUARD D4/A0
6-8-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

5

6

7

8

TIME
(MIN'S)

0	83.3	82.1	82.4	82.2
4	83.8	174.9	161.1	179.4
8	87.4	313.4	286.6	320.2
12	94.1	478.8	452.9	481.7
16	106.6	645.6	631.9	646.6
20	122.2	785.8	773.0	799.4
24	142.5	876.2	858.9	889.3
28	165.0	942.1	926.1	951.3
32	188.1	985.5	970.6	987.8
36	209.3	1018.3	1004.6	1019.1
40	229.6	1048.7	1036.0	1049.5
44	251.4	1069.6	1059.8	1073.0
48	269.0	1088.5	1078.8	1089.4
52	289.7	1102.6	1094.7	1103.3
56	305.2	1114.8	1105.7	1115.1
60	319.8	1126.2	1117.0	1124.4

US COAST GUARD D4/A0
6-8-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

9

10

11

12

TIME
(MIN'S)

0	82.4	84.8	85.0	85.4
4	158.2	328.9	310.7	439.9
8	282.5	682.1	629.6	864.9
12	446.2	897.6	815.5	1014.6
16	617.5	1024.8	929.8	1110.6
20	772.7	1134.7	987.2	1156.9
24	850.6	1219.7	1029.6	1187.1
28	918.2	1278.6	1075.5	1221.9
32	962.4	1322.8	1116.8	1249.2
36	991.7	1362.6	1155.8	1280.0
40	1020.6	1402.0	1189.0	1304.6
44	1040.7	1431.6	1219.2	1329.0
48	1057.2	1455.2	1246.7	1350.7
52	1069.9	1475.4	1269.5	1369.8
56	1080.6	1485.7	1290.1	1383.4
60	1090.9	1505.5	1306.3	1402.1

T E S T R E C O R D D4/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D4/A60 and as shown in ILL. 24.

The fire and hose stream tests were conducted on July 17, 1984.

RESULTS

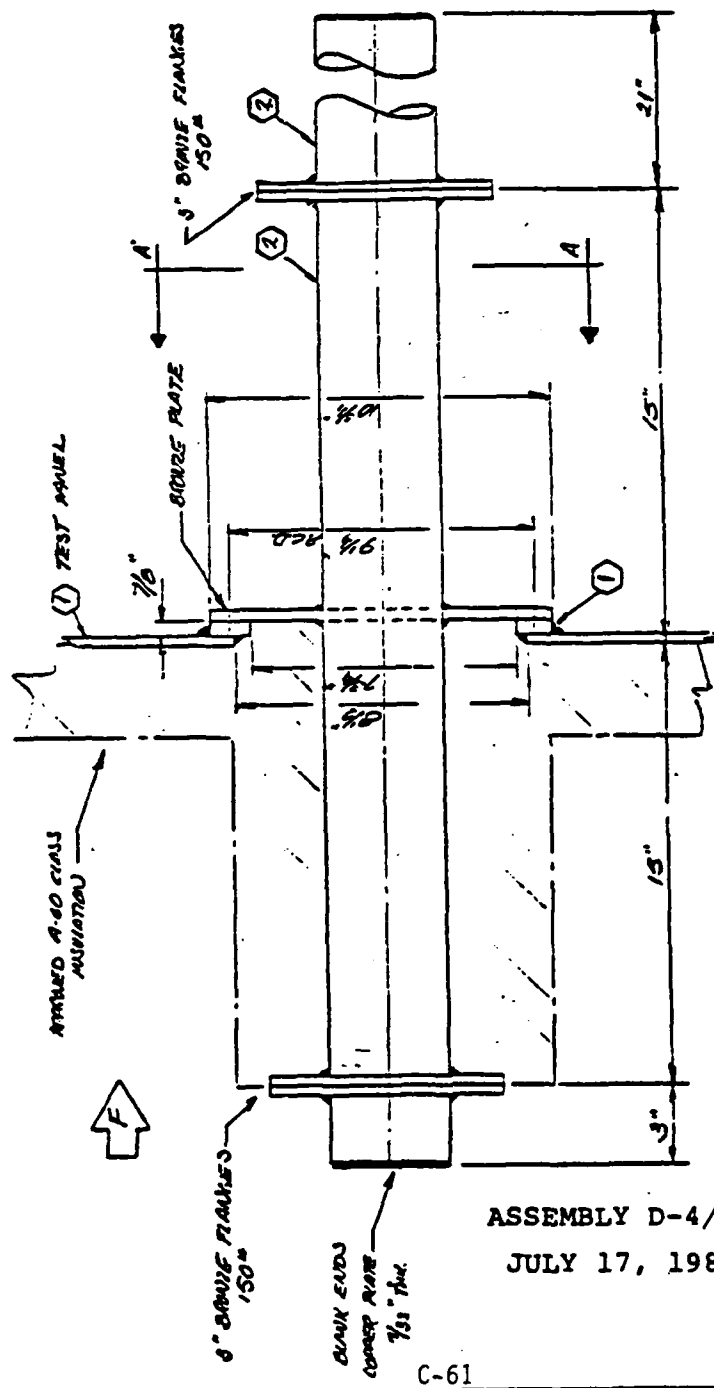
Observations During Fire Tests - By 24 min, the 3 in. bronze flange, on the exposed side of the assembly, had separated from the copper pipe and fell into the furnace chamber.

No significant changes occurred during remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 25.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 26 through 26B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-4/A60
JULY 17, 1984

C-61

PENETRATION NO D-4
(CORNER)

- ① STEEL PLATE 3/4" THK, ASTM A53 GRADE A-PB
- ② 3" RADIUS, CORNER ARE ASTM A-42

TITLE:	DECK PENETRATION
DATE:	NOV 89
DESIGNED BY:	703
CHECKED BY:	
SCALE:	
FIG. NO.:	D-4

SAMPLE D-4/A60
TEST DATE JULY 17, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 15 in. above unexposed surface.
4	On penetrant, 17 in. above unexposed surface.
5	On penetrant, 24 in. above unexposed surface.
6	On unexposed surface, 1 in. from penetrant.
7	On unexposed surface, 1 in. from penetrant.
8	On unexposed surface, at the periphery of opening.
9	On unexposed surface, at the periphery of firestop.
10	On unexposed surface, 1 in. from periphery of firestop.
11	On unexposed surface, 12 in. from edge of opening.
12	On unexposed surface, 12 in. from edge of opening.

USNC142
ILL. 25

US COAST GUARD D4/A60
7-17-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	1	2	3	4
TIME (MIN'S)				
0	83.3	83.4	83.5	83.6
4	83.9	83.8	83.7	83.9
8	86.9	85.3	84.3	84.2
12	93.8	89.8	85.6	84.8
16	107.5	97.1	88.2	85.6
20	128.2	110.3	92.9	87.4
24	155.3	127.5	97.9	89.5
28	187.7	148.9	106.3	93.1
32	218.5	170.6	115.6	95.9
36	253.5	196.0	126.9	101.6
40	287.7	220.6	138.7	108.7
44	325.3	246.0	151.3	116.0
48	383.0	281.9	166.4	124.1
52	437.9	321.6	184.7	133.1
56	486.2	356.2	202.9	144.2
60	531.8	387.9	219.1	155.1

US COAST GUARD D4/A60
7-17-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

5

6

7

8

TIME
(MIN'S)

0	83.8	84.1	85.1	84.2
4	84.1	83.0	84.8	84.1
8	84.4	86.4	86.8	86.2
12	84.9	93.1	92.5	91.8
16	85.4	103.7	101.8	101.0
20	86.7	121.8	118.4	117.3
24	88.1	145.7	141.1	139.3
28	90.3	174.9	169.2	166.6
32	92.8	203.1	198.2	195.0
36	95.3	235.5	229.8	225.5
40	100.5	267.3	261.7	258.1
44	106.0	302.8	296.7	292.2
48	111.9	354.7	347.4	340.6
52	118.0	404.6	396.5	398.7
56	124.9	450.4	442.3	432.8
60	131.6	494.2	486.1	474.3

US COAST GUARD D4/A60
7-17-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
0	84.6	84.0	84.3	85.7
4	84.3	84.0	85.1	86.1
8	85.0	86.5	87.4	88.3
12	90.7	89.6	91.2	92.2
16	98.0	94.8	97.1	98.4
20	111.9	106.8	108.8	110.6
24	130.5	121.7	122.8	125.1
28	154.6	139.3	137.1	140.0
32	179.6	158.0	151.0	156.3
36	205.7	179.1	164.8	172.9
40	234.7	200.7	178.6	189.2
44	264.8	221.9	190.9	203.6
48	306.5	243.6	202.8	217.9
52	349.3	268.9	214.6	230.9
56	391.5	297.6	227.1	244.1
60	432.0	324.0	228.4	255.6

T E S T R E C O R D D5/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D5/A0 and as shown in ILL. 27.

The fire and hose stream tests were conducted on June 6, 1984.

RESULTS

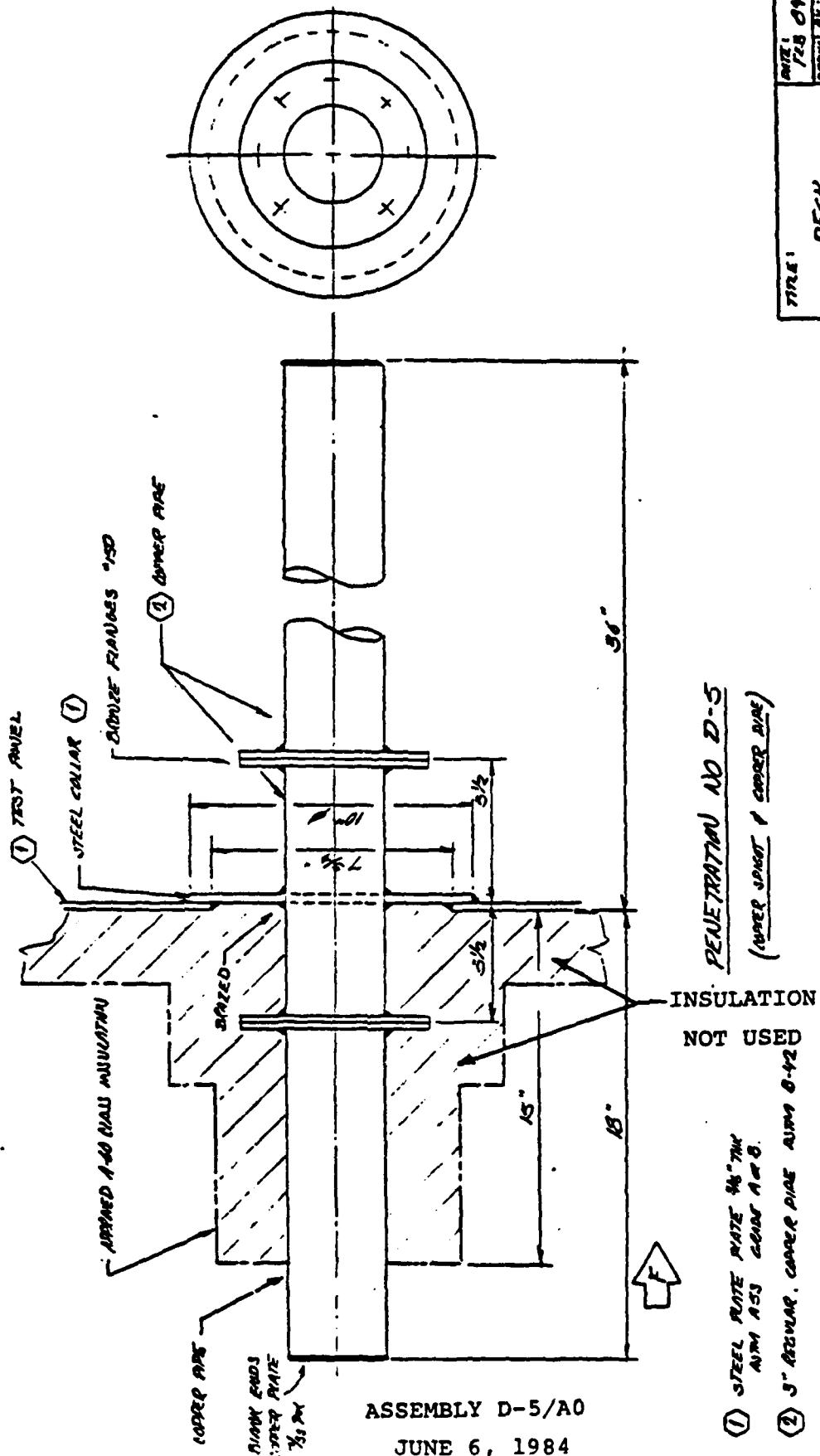
Observations During Fire Test - By 38 min, the 3 in. bronze flange, on the exposed side of the assembly, had separated from the copper pipe and fell into the furnace chamber. By 50 min, the unexposed surface of the deck was glowing red.

No significant changes occurred during the remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 28.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 29 through 29C.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



TYPE:	DECK	DATE:	7/28/84
	PENETRATION	BY:	7/28
		SCALE:	
		REV:	

PENETRATION NO D-5
(UNDER SPOT & CORNER RISE)

① STEEL PLATE RATE 1/2" THK
A191 A53 CLASS A & B.

② 3" ABSORBER, CORNER PLATE A191 B-42

SAMPLE D-5/AO
TEST DATE JUNE 6, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 12 in. above unexposed surface.
4	On penetrant, 18 in. above unexposed surface.
5	On penetrant, 24 in. above unexposed surface.
6	On unexposed surface, interface of penetrant and steel collar.
7	On unexposed surface, equidistant from penetrant and firestop periphery.
8	On unexposed surface, equidistant from penetrant and firestop periphery.
9	On unexposed surface, equidistant from penetrant and firestop periphery.
10	On unexposed surface, periphery of opening.
11	On unexposed surface, periphery of firestop.
12	On unexposed surface, 6 in. from edge of opening.
13	On unexposed surface, 6 in. from edge of opening.
14	On unexposed surface, 12 in. from edge of opening.
15	On unexposed surface, 12 in. from edge of opening.

USNC142
ILL. 28

US COAST GUARD D5/A0
6-6-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	89.8	86.2	85.0	86.2
4	186.5	91.9	89.9	88.3
8	339.1	110.6	103.8	94.7
12	495.1	153.9	136.3	112.7
16	633.7	205.6	184.0	141.0
20	741.0	270.1	236.7	174.6
24	827.8	191.2	292.2	213.0
28	903.2	224.4	344.1	250.5
32	972.5	245.1	393.5	287.5
36	1021.4	230.0	437.4	321.8
40	1065.4	275.1	477.7	353.6
44	1090.8	573.3	511.2	381.4
48	1116.8	624.7	543.3	407.6
52	1141.1	655.8	566.3	429.0
56	1164.5	680.3	587.1	448.4
60	1181.9	698.7	603.9	464.1

US COAST GUARD D5/A0
6-6-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

5

6

7

8

TIME
(MIN'S)

0	86.3	91.2	89.6	92.8
4	87.0	225.7	187.9	272.7
8	92.8	424.7	402.3	563.9
12	102.9	604.5	566.5	768.9
16	120.5	758.6	742.2	919.4
20	141.9	871.1	826.9	1012.0
24	168.3	957.3	900.4	1086.3
28	195.0	1036.2	984.7	1163.9
32	222.5	1107.1	959.9	1233.5
36	248.6	1154.9	1103.7	1279.2
40	274.3	1196.2	1062.2	1313.8
44	296.8	1216.2	1176.0	1332.5
48	319.3	1239.9	1075.2	1356.9
52	337.5	1264.5	1124.8	1384.2
56	354.5	1288.2	1203.7	1409.0
60	369.1	1307.4	1187.9	1430.0

US COAST GUARD DS/A0
6-6-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
0	92.8	94.6	0.0	98.7
4	275.5	294.1	306.0	443.0
8	547.9	571.2	579.5	866.7
12	743.0	773.2	775.5	1034.5
16	890.3	914.5	909.7	1125.6
20	983.2	997.5	990.3	1165.2
24	1056.7	1060.2	1046.1	1207.5
28	1160.4	1137.5	1124.6	1233.3
32	1233.6	1198.4	1184.1	1284.0
36	1256.2	1240.9	1226.2	1316.5
40	1299.9	1277.2	1259.9	1347.8
44	1268.0	1294.5	1278.4	1353.7
48	1329.3	1312.3	1293.6	1374.9
52	1350.3	1334.2	1315.5	1400.3
56	1368.3	1357.0	1339.4	1425.5
60	1388.1	1379.6	1359.9	1443.0

US COAST GUARD D5/A0
6-6-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	13	14	15
TIME			
(MIN'S)			
0	89.0	101.7	96.6
4	94.7	395.3	302.4
8	185.5	759.6	652.6
12	202.5	945.5	859.8
16	214.1	1054.0	966.8
20	215.9	1104.5	1024.6
24	1157.2	1153.4	1069.1
28	1158.8	1171.5	1072.7
32	1205.8	1215.7	1114.2
36	1243.8	1251.7	1151.0
40	1281.9	1284.2	1188.6
44	1294.0	1293.9	1202.4
48	1314.1	1313.5	1223.4
52	1339.0	1334.9	1248.2
56	1363.4	1359.2	1270.8
60	1386.9	1377.0	1290.8

T E S T R E C O R D D5/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D5/A60 and as shown in ILL. 30.

The fire and hose stream tests were conducted on June 20, 1984.

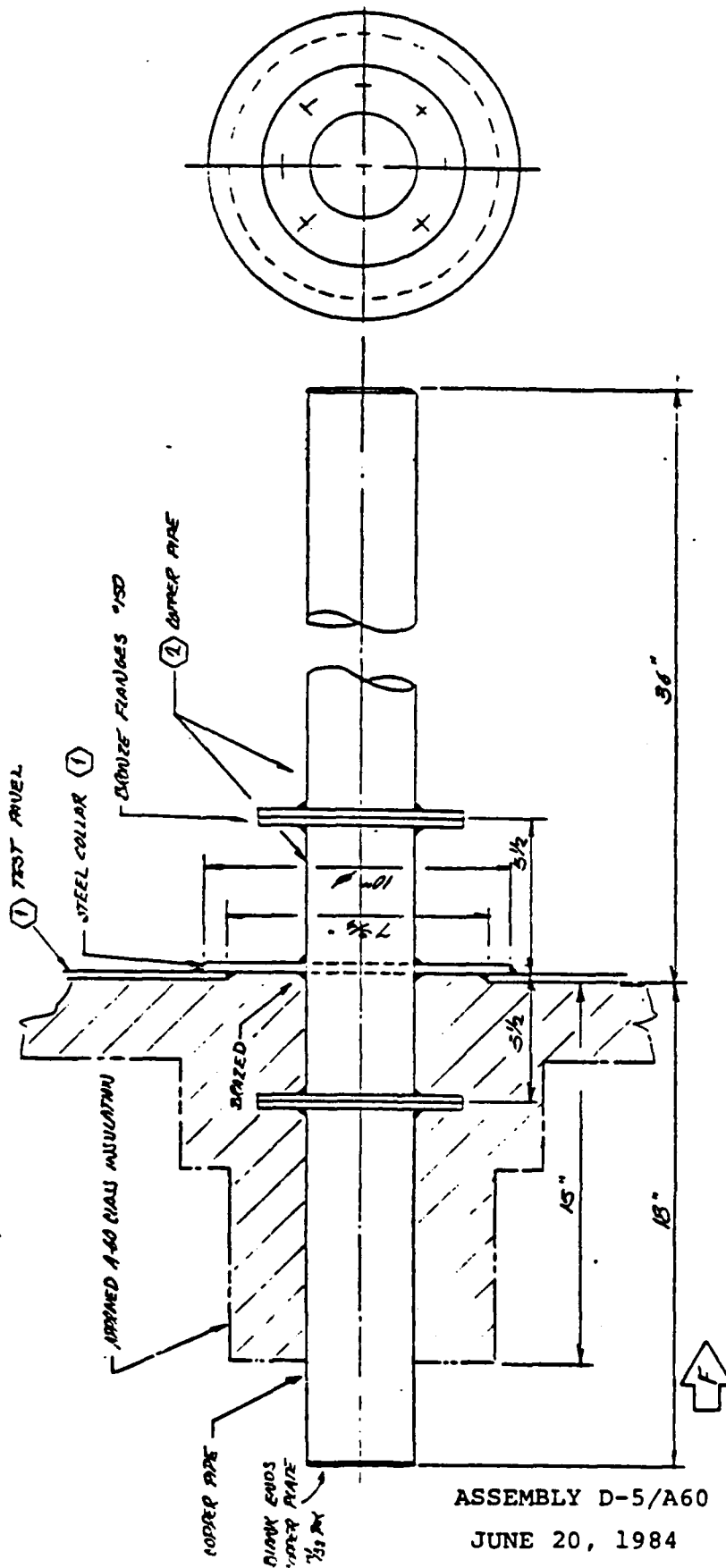
RESULTS

Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 31.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 32 through 32C.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-5/A60

JUNE 20, 1984

PENETRATION NO D-5
(UPPER SPACER & COPPER RING)

- (1) STEEL RING RING 1/8" THK
ALUM A63 COAT A608
- (2) 3" REGULAR COPPER RING ALUM B-42

TITLE:	DECK
DATE:	12/8/84
DESIGNED BY:	7/8
SCALE:	1"=1'
DRAWN BY:	D-5

SAMPLE D-5/A60
TEST DATE JUNE 20, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 12 in. above unexposed surface.
4	On penetrant, 18 in. above unexposed surface.
5	On penetrant, 24 in. above unexposed surface.
6	On unexposed surface, interface of penetrant and steel collar.
7	On unexposed surface, equidistant from penetrant and firestop.
8	On unexposed surface, equidistant from penetrant and firestop.
9	On unexposed surface, equidistant from penetrant and firestop.
10	On unexposed surface, periphery of opening.
11	On unexposed surface, periphery of firestop.
12	On unexposed surface, 6 in. from edge of opening.
13	On unexposed surface, 6 in. from edge of opening.
14	On unexposed surface, 12 in. from edge of opening.
15	On unexposed surface, 12 in. from edge of opening.

USNC142
ILL. 31

US COAST GUARD D5/A60
6-20-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	1	2	3	4
TIME (MIN'S)				
0	72.0	72.8	72.9	72.9
4	73.5	72.0	72.0	72.0
8	75.8	73.4	73.4	73.5
12	81.6	74.3	74.3	74.3
16	91.3	76.1	75.8	75.4
20	103.1	79.2	77.0	76.9
24	118.7	83.7	81.1	78.7
28	136.8	89.6	84.0	81.1
32	157.0	95.8	90.1	84.1
36	177.9	104.2	95.0	87.8
40	199.7	113.5	101.8	91.8
44	222.2	124.0	109.4	95.3
48	244.8	135.5	118.0	100.7
52	267.7	147.5	127.0	106.6
56	290.5	160.9	136.7	113.3
60	312.1	173.7	146.9	120.1

US COAST GUARD D5/A60
6-20-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	72.0	72.6	72.8	72.8
4	72.9	72.4	73.3	73.3
8	73.2	73.0	74.8	74.7
12	73.7	78.4	78.8	78.5
16	74.5	85.9	85.8	85.5
20	75.7	95.0	94.6	94.0
24	77.1	107.7	107.0	106.6
28	78.9	122.8	122.0	121.7
32	81.1	140.4	138.9	138.7
36	83.8	159.3	157.3	157.4
40	86.8	179.1	175.9	175.6
44	90.2	199.5	194.9	194.9
48	93.3	221.4	215.2	215.1
52	97.9	242.8	235.4	234.9
56	103.0	257.3	255.1	253.9
60	108.6	276.6	275.2	272.4

US COAST GUARD D3/A60
6-20-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
0	72.8	72.8	72.9	72.6
4	73.2	72.0	73.1	73.2
8	74.2	73.9	73.0	75.4
12	77.2	76.8	76.6	79.4
16	82.7	81.9	81.1	84.5
20	90.5	89.4	87.7	92.9
24	99.7	98.3	96.0	104.3
28	112.4	110.9	108.0	119.5
32	127.2	125.7	122.1	134.7
36	144.0	142.1	137.5	147.8
40	161.2	158.7	152.3	160.9
44	178.2	175.3	168.0	177.5
48	197.0	193.3	185.3	192.9
52	215.9	211.4	202.4	207.6
56	235.0	228.6	219.3	221.0
60	252.9	245.8	235.3	232.5

US COAST GUARD D5/A60
6-20-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	13	14	15
TIME (MIN'S)			
0	73.0	72.2	72.7
4	78.3	72.9	73.8
8	85.8	75.2	75.4
12	95.2	79.2	77.0
16	101.7	84.2	81.6
20	105.8	92.3	87.2
24	109.4	103.3	94.2
28	116.0	118.1	104.1
32	122.3	132.7	114.8
36	118.9	145.1	124.3
40	121.8	156.0	133.0
44	126.6	170.5	142.3
48	125.7	183.9	152.2
52	130.4	196.7	161.8
56	134.3	208.6	170.4
60	135.1	219.7	179.2

T E S T R E C O R D D6/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D6/A0 and as shown in ILL. 33.

The fire and hose stream tests were conducted on June 7, 1984.

RESULTS

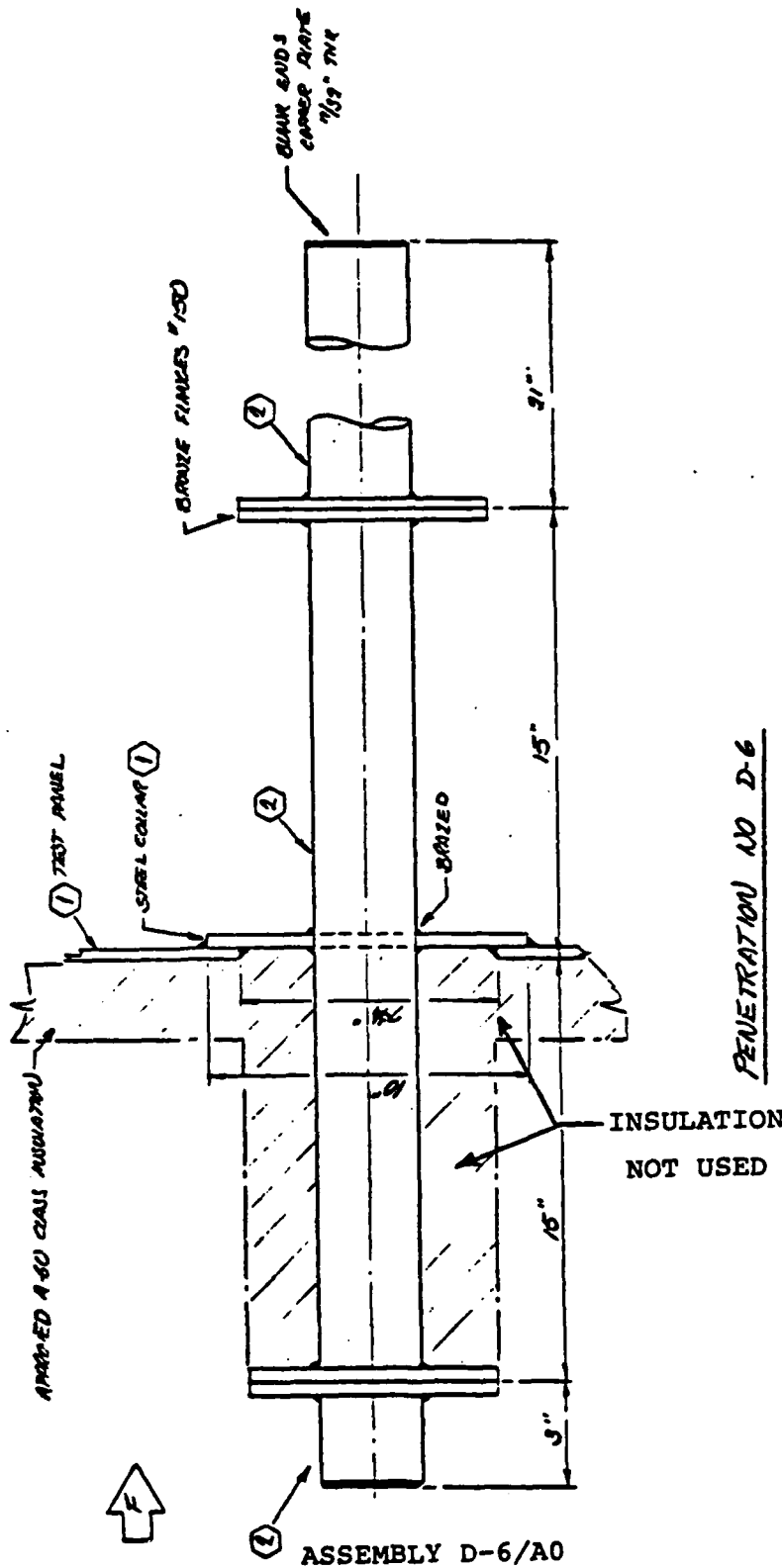
Observations During Fire Test - By 18 min, the 3 in. bronze flange, on the exposed side of the assembly, had separated from the copper pipe and fell into the furnace chamber. By 40 min, the unexposed surface of the deck was glowing red.

No significant changes occurred during the remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 34.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 35 through 35C.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-6/A0
JUNE 7, 1984

PENETRATION NO D-6
(CORNER SPIGOT & CARRIER PLATE)

- ① STEEL FRAME 3/8" THK. AUTHN A-53 CORNER PLATE
- ② 3" INSULATION, CORNER ARE AUTHN B-42

TITLE:	DECK
DATE:	1500 87
DESIGNED BY:	YAG
CHECKED BY:	
DATE:	
DRWING NO:	D-6

USNC142

ILL. 33

SAMPLE D-6/AO
TEST DATE JUNE 7, 1984

<u>T.C.</u>	<u>Location</u>
1	On the penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 12 in. above unexposed surface.
4	On penetrant, 18 in. above unexposed surface.
5	On penetrant, 24 in. above unexposed surface.
6	On unexposed surface, at the interface of penetrant and cover plate.
7	On unexposed surface, equidistant from penetrant and firestop.
8	On unexposed surface, equidistant from penetrant and firestop.
9	On unexposed surface, equidistant from penetrant and firestop.
10	On unexposed surface, at the periphery of opening.
11	On unexposed surface, at the periphery of firestop.
12	On unexposed surface, 6 in. from edge of opening.
13	On unexposed surface, 6 in. from edge of opening.
14	On unexposed surface, 12 in. from edge of opening.
15	On unexposed surface, 12 in. from edge of opening.

USNC142
ILL. 34

US COAST GUARD D6/A0
6-7-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	81.5	80.8	80.4	81.6
4	177.8	120.8	91.2	82.3
8	372.9	221.5	127.7	83.5
12	587.8	372.4	200.9	97.6
16	761.1	509.5	279.7	121.4
20	853.1	605.4	344.7	153.7
24	942.7	670.7	401.1	189.1
28	999.5	723.3	449.9	224.6
32	1042.9	763.1	490.1	258.7
36	1073.4	793.1	524.3	291.0
40	1097.2	816.3	552.0	320.0
44	1116.8	836.4	578.8	346.0
48	1133.6	854.4	599.3	369.8
52	1151.0	870.3	617.7	389.5
56	1164.1	883.5	636.2	409.3
60	1178.1	895.7	651.2	425.3

US COAST GUARD D6/A0
6-7-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	80.5	82.3	82.9	83.1
4	81.4	213.5	230.8	228.2
8	84.9	460.8	543.9	546.5
12	94.0	697.0	810.5	822.9
16	109.9	873.6	974.0	996.9
20	130.4	972.9	1081.2	1084.7
24	154.5	1064.2	1166.3	1158.1
28	179.7	1124.3	1216.8	1205.0
32	205.0	1167.1	1260.7	1248.5
36	228.7	1197.3	1288.4	1278.2
40	251.5	1220.0	1306.6	1302.8
44	273.1	1242.8	1323.5	1324.0
48	293.5	1259.2	1337.2	1343.7
52	310.8	1281.0	1364.3	1366.3
56	327.5	1293.7	1372.9	1382.3
60	341.2	1312.1	1388.1	1398.5

US COAST GUARD D6/A0
6-7-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
0	82.9	83.4	83.7	84.2
4	204.3	220.7	224.4	312.5
8	504.3	533.0	553.3	765.1
12	797.7	815.7	849.4	1020.8
16	962.7	983.4	1000.6	1134.8
20	1046.6	1082.7	1094.3	1176.4
24	1113.5	1170.5	1180.8	1216.1
28	1164.8	1226.7	1235.4	1256.8
32	1208.2	1274.6	1281.4	1295.0
36	1240.6	1305.9	1310.8	1322.2
40	1269.2	1331.7	1336.2	1345.3
44	1292.1	1359.4	1363.8	1370.1
48	1314.5	1381.2	1385.2	1391.9
52	1334.2	1406.2	1408.1	1405.7
56	1354.0	1422.5	1421.2	1421.4
60	1371.2	1443.8	1440.9	1436.2

US COAST GUARD D6/A0
6-7-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

13

14

15

TIME
(MIN'S)

0	83.4	84.5	84.5
4	88.1	279.5	280.2
8	90.4	654.2	686.0
12	869.7	907.5	886.2
16	1045.8	1023.7	1003.6
20	1157.1	1071.0	1081.3
24	1250.3	1111.6	1161.8
28	1292.3	1153.1	1202.4
32	1334.1	1191.1	1246.2
36	1164.8	1220.1	1276.2
40	1152.0	1247.4	1301.4
44	1171.9	1271.4	1318.1
48	1405.8	1297.3	1333.5
52	1428.5	1315.2	1363.8
56	1418.4	1331.1	1374.6
60	1210.7	1348.1	1396.4

T E S T R E C O R D D6/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D6/A60 and as shown in ILL. 36.

The fire and hose stream tests were conducted on June 21, 1984.

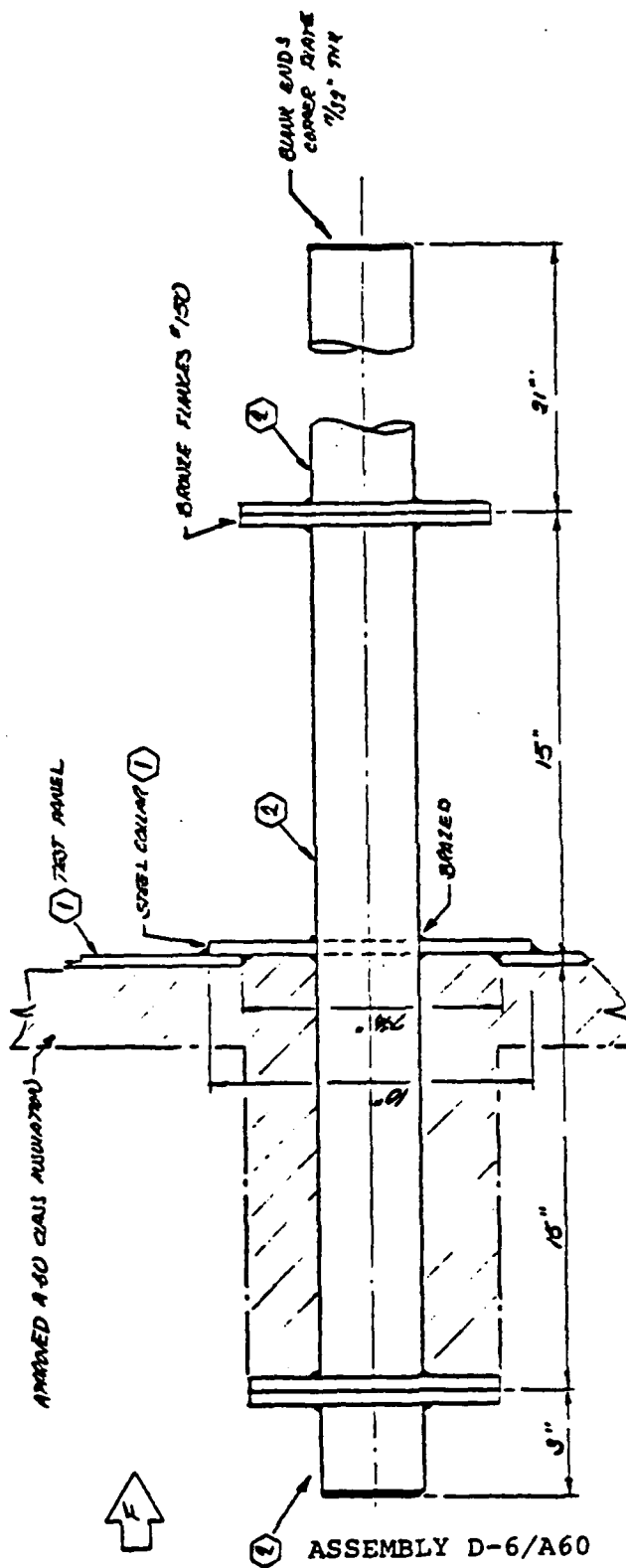
RESULTS

Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 37.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 38 through 38C.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-6/A60
JUNE 21, 1984

PENETRATION NO D-6

(CORNER JOINT & CORNER PLATE)

① STEEL PLATE 3/4" THK. AUTH A-53 CORNER A60B

② 3" REGULAR, CORNER ARE AUTH B-12

DATE:	1/20/84
DESIGNED BY:	YXB
WALL:	
REV:	
TITLE:	DECK PENETRATION
SCALE:	D. 6

SAMPLE D-6/A60
TEST DATE JUNE 21, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 12 in. above unexposed surface.
4	On penetrant, 18 in. above unexposed surface.
5	On penetrant, 24 in. above unexposed surface.
6	On unexposed surface, at the interface of penetrant and cover plate.
7	On unexposed surface, equidistant from penetrant and firestop.
8	On unexposed surface, equidistant from penetrant and firestop.
9	On unexposed surface, equidistant from penetrant and firestop.
10	On unexposed surface, at the periphery of opening.
11	On unexposed surface, at the periphery of firestop.
12	On unexposed surface, 6 in. from edge of opening.
13	On unexposed surface, 6 in. from edge of opening.
14	On unexposed surface, 12 in. from edge of opening.
15	On unexposed surface, 12 in. from edge of opening.

USNC142
ILL. 37

US COAST GUARD D6/A60
6-21-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	72.0	72.0	72.0	73.3
4	74.1	73.5	73.4	73.6
8	79.4	76.1	74.4	73.9
12	93.1	84.3	77.5	74.5
16	115.6	98.4	83.8	75.4
20	148.3	120.5	92.8	77.1
24	188.2	148.5	106.2	79.7
28	229.8	179.0	122.2	83.5
32	271.9	210.1	139.8	88.3
36	314.0	241.4	158.7	93.9
40	354.6	272.1	177.5	101.1
44	391.5	300.9	196.0	108.6
48	425.0	327.0	213.0	116.7
52	455.9	351.3	229.8	125.8
56	481.9	372.7	245.6	135.2
60	504.9	391.7	259.6	144.4

US COAST GUARD D6/A60
6-21-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

5

6

7

8

TIME
(MIN'S)

0	73.3	73.4	73.3	73.2
4	73.6	75.4	74.6	75.9
8	73.8	78.6	77.1	77.7
12	74.3	89.9	85.9	87.8
16	74.0	108.5	100.2	104.2
20	76.2	136.3	121.8	129.1
24	78.1	171.7	149.2	160.5
28	80.8	211.2	180.2	195.0
32	84.2	241.1	213.2	231.1
36	89.2	277.9	247.1	268.5
40	93.9	315.4	280.8	305.7
44	99.8	350.0	312.8	339.7
48	106.0	382.6	341.9	370.3
52	112.6	413.4	368.6	397.5
56	119.8	440.2	392.2	421.0
60	127.2	464.5	412.4	441.4

US COAST GUARD D6/A60
6-21-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
0	73.3	73.5	73.5	73.5
4	77.7	77.0	74.0	74.6
8	76.6	76.6	76.2	77.6
12	84.1	81.3	81.1	82.2
16	96.6	89.0	90.1	90.2
20	116.5	102.8	103.7	103.3
24	142.3	121.6	124.0	122.0
28	172.2	144.0	147.7	141.1
32	203.9	168.7	172.3	158.3
36	237.2	195.1	199.2	178.5
40	270.3	222.3	226.0	198.3
44	301.4	248.6	251.7	217.3
48	330.2	273.2	275.7	233.8
52	360.9	296.4	298.0	249.4
56	388.9	317.6	318.0	263.0
60	411.5	335.4	334.9	275.7

US COAST GUARD D6/A60
6-21-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

13

14

15

TIME
(MIN'S)

0	75.7	73.4	73.6
4	78.5	75.4	74.8
8	82.8	76.7	75.8
12	93.3	81.3	78.6
16	91.2	89.4	81.0
20	97.4	102.1	87.2
24	102.9	119.4	94.1
28	107.7	135.9	104.6
32	117.4	150.3	116.6
36	117.9	166.4	128.4
40	132.6	180.9	140.1
44	137.5	194.2	151.4
48	149.4	206.6	163.1
52	140.0	217.6	173.8
56	139.3	228.6	183.9
60	152.5	239.5	194.0

T E S T R E C O R D D7/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D7/A0 and as shown in ILL. 39

The fire and hose stream tests were conducted on June 7, 1984.

RESULTS

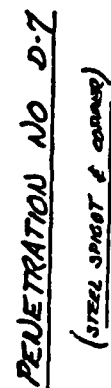
Observations During Fire Test - By 37 min, the unexposed surface of the deck was glowing red.

No significant changes occurred during the remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 40.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 41 through 41B.

Pictorial History - Due to the malfunction of photographic equipment, photographs were not obtained during the fire test, hose stream test, and after the hose stream test.



④ FIFTY SEVENTH

6-95

SAMPLE D-7/AO
TEST DATE JUNE 7, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 12 in. above unexposed surface.
4	On penetrant, at the interface of steel pipe and copper pipe.
5	On penetrant, 13 in. above unexposed surface.
6	On penetrant, 24 in. above unexposed surface.
7	At interface of penetrant and unexposed surface.
8	On unexposed surface, 6 in. from penetrant.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 12 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 40

US COAST GUARD D7/A0
6-7-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	1	2	3	4
TIME (MIN'S)				
0	87.2	84.3	83.9	83.5
4	181.3	98.9	88.8	84.9
8	359.1	160.0	110.3	94.0
12	531.3	265.2	166.1	136.2
16	653.5	364.0	218.4	181.1
20	736.1	452.9	266.8	231.5
24	795.9	519.4	316.3	289.2
28	843.5	572.1	364.8	346.1
32	886.6	621.3	411.7	395.1
36	922.3	658.5	451.4	442.5
40	952.4	691.2	486.3	491.3
44	979.4	722.2	518.1	531.0
48	1000.2	747.6	545.7	562.8
52	1018.7	768.8	566.0	588.9
56	1033.1	784.9	585.6	611.2
60	1051.8	801.1	600.9	629.2

US COAST GUARD D7/A0
6-7-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	83.6	83.7	90.7	93.4
4	85.2	85.1	283.7	475.9
8	92.5	90.6	575.0	941.4
12	123.7	104.7	791.8	1076.9
16	162.1	129.0	912.5	1155.7
20	203.6	157.2	988.4	1203.3
24	251.3	188.6	1043.4	1242.3
28	302.1	224.4	1090.3	1289.3
32	350.9	261.5	1133.9	1327.0
36	394.2	296.4	1172.0	1365.7
40	432.1	330.2	1201.4	1394.0
44	467.1	360.0	1228.0	1417.6
48	496.3	386.6	1250.9	1437.0
52	521.9	410.1	1271.5	1453.7
56	542.9	431.2	1290.4	1466.9
60	559.8	447.8	1306.3	1479.3

US COAST GUARD D7/A0
6-7-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

9

10

11

TIME
(MIN'S)

0	93.5	96.5	0.0
4	429.9	423.9	405.9
8	844.8	799.5	732.5
12	999.1	977.5	923.1
16	1082.0	1065.8	1019.1
20	1137.4	1115.8	1068.1
24	1177.6	1155.9	1105.7
28	1218.7	1199.1	1146.5
32	1260.0	1240.3	1188.9
36	1295.7	1277.2	1227.3
40	1321.1	1308.8	1256.5
44	1346.5	1331.2	1281.0
48	1369.5	1351.9	1303.5
52	1389.1	1371.7	1325.3
56	1406.6	1390.0	1342.2
60	1419.5	1404.3	1357.2

T E S T R E C O R D D7/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D7/A60 and as shown in ILL. 42.

The fire and hose stream tests were conducted on June 21, 1984.

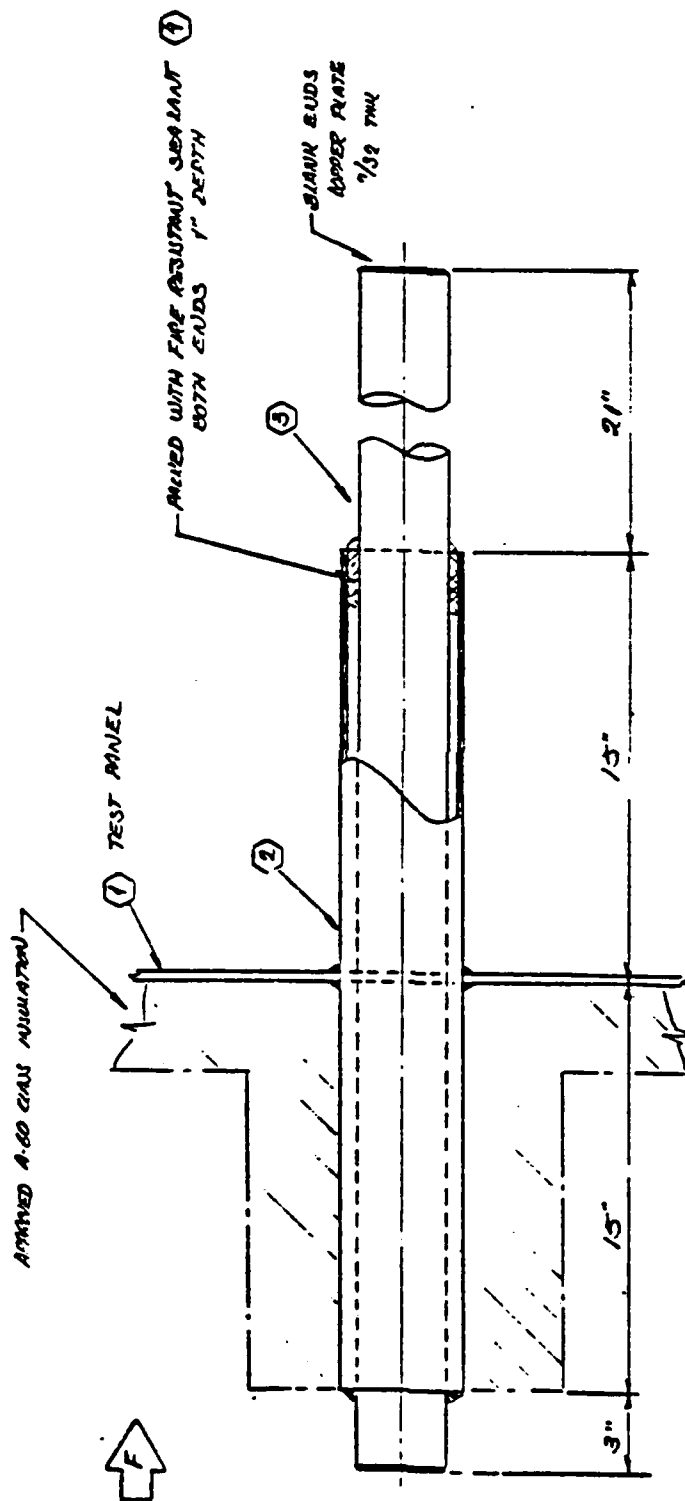
RESULTS

Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 43.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 44 through 44B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-7/A60

JUNE 21, 1984

PENETRATION NO D-7

(STEEL SHOT & CORNER)

- ① STEEL PLATE 9/16" THU, ASTM A-53
GRADE A OR B
- ② 4" SCH 40, SEAMLESS STEEL PIPE
ASTM A-53 GRADE A OR B
- ③ 3" REGULAR COPPER PIPE, ASTM B-42
- ④ FIRE SEALANT

TITLE:	DECK
DATE:	2-8-84
DRAWN BY:	YB
CHECKED BY:	
SCALE:	
FIG. NO.:	D-7

SAMPLE D-7/A60
TEST DATE JUNE 21, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 12 in. above unexposed surface.
4	On penetrant, at the interface of steel plate and copper plate.
5	On penetrant, 13 in. above unexposed surface.
6	On penetrant, 24 in. above unexposed surface.
7	At interface of penetrant and unexposed surface.
8	On unexposed surface, 6 in. from penetrant.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 12 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 43

US COAST GUARD D7/A60
6-21-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	77.7	77.7	77.7	76.0
4	78.1	77.0	77.0	77.4
8	78.0	78.7	78.6	78.7
12	81.5	80.1	79.8	83.1
16	85.0	82.4	81.6	91.2
20	93.6	86.5	85.1	102.6
24	103.5	92.8	90.6	118.4
28	118.0	99.7	96.4	135.6
32	135.0	109.8	104.8	153.6
36	152.6	121.5	114.5	171.7
40	171.3	135.1	124.8	189.6
44	195.2	149.5	136.4	207.1
48	219.3	162.8	148.3	224.0
52	242.6	177.7	160.2	240.5
56	265.8	194.0	172.3	256.6
60	287.5	208.9	183.0	272.4

US COAST GUARD D7/A60
6-21-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

5

6

7

8

TIME
(MIN'S)

0	76.0	77.4	79.9	81.3
4	77.3	77.7	80.1	81.6
8	78.4	78.4	80.7	83.6
12	81.7	79.8	83.4	87.7
16	88.3	82.6	88.4	95.1
20	97.6	87.5	95.7	109.2
24	111.3	93.6	108.1	126.1
28	126.5	102.3	124.1	141.8
32	142.8	112.9	142.2	157.5
36	159.3	124.1	160.9	174.7
40	176.0	136.6	184.0	191.7
44	192.2	148.7	209.9	208.5
48	208.0	161.0	235.6	224.4
52	223.0	172.9	260.8	239.7
56	238.5	185.0	286.4	254.3
60	252.3	196.3	309.7	267.7

US COAST GUARD D7/A60
6-21-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11
TIME (MIN'S)			
0	80.9	80.9	81.4
4	81.5	81.0	82.2
8	83.5	84.0	83.9
12	86.0	90.4	86.9
16	92.0	100.1	92.3
20	102.9	117.5	100.6
24	117.9	137.8	113.3
28	132.8	154.3	126.6
32	146.1	171.7	138.9
36	161.5	188.8	151.0
40	176.9	204.3	164.4
44	191.8	218.9	176.8
48	205.5	231.7	188.6
52	219.0	244.7	199.8
56	231.4	257.7	210.7
60	242.6	268.7	220.0

T E S T R E C O R D D8/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D8/A0 and as shown in ILL. 45.

The fire and hose stream tests were conducted on June 6, 1984.

RESULTS

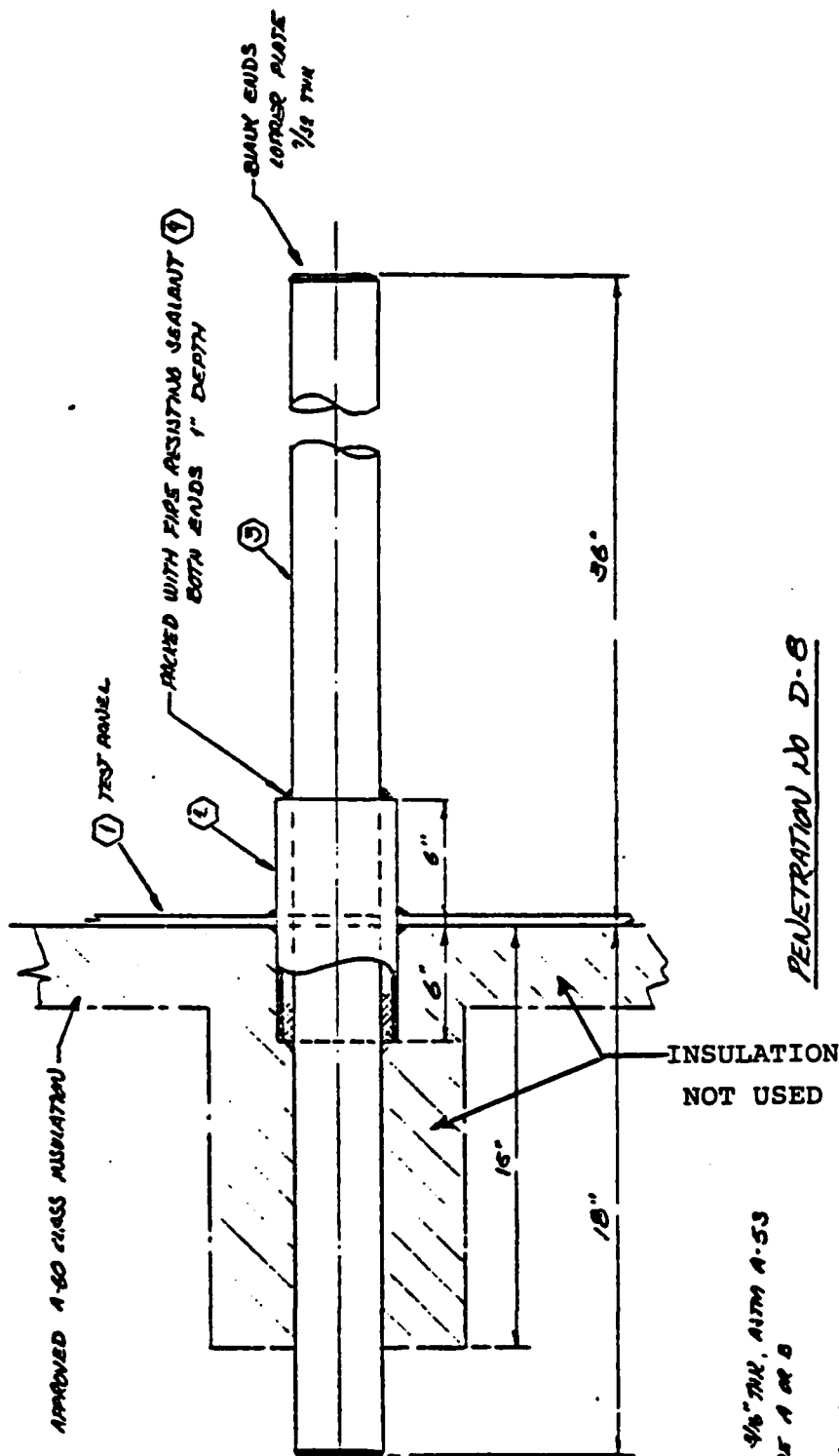
Observations During Fire Test - By 40 min, the unexposed surface of the deck was glowing red.

No significant changes occurred during the remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 46.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 47 through 47B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-8/A0
JUNE 6, 1984

PENETRATION NO D-8
(STEEL SHEET & CORNER)

- ① STEEL PLATE 3/8" THK, ASTM A-53
GRADE A OR B
- ② 1" SOUND, SEMI-LESS STEEL PIPE, ASTM A-53
GRADE A OR B
- ③ 3" REGULAR CORNER PIPE ASTM B-42
- ④ FIRE SEALANT

TITLE: <u>DECK</u>		DATE: <u>7/8/84</u>
SUBTITLE: <u>PENETRATION</u>		DESIGNED BY: <u>YB</u>
DRAWING NO: <u>D-8</u>		SCALE: <u>1" = 1'</u>

SAMPLE D-8/AO
TEST DATE JUNE 6, 1984

<u>T.C.</u>	<u>Location</u>
1	On the surface of penetrant, 1 in. above unexposed surface.
2	On the surface of penetrant, 6 in. above unexposed surface.
3	On the surface of penetrant, 12 in. above unexposed surface.
4	On the surface of penetrant, 18 in. above unexposed surface.
5	On the surface of penetrant, 24 in. above unexposed surface.
6	On the unexposed surface, at interface of penetrant and unexposed surface.
7	On the unexposed surface, 1 in. from penetrant.
8	On the unexposed surface, 6 in. from penetrant.
9	On the unexposed surface, 6 in. from penetrant.
10	On the unexposed surface, 12 in. from penetrant.
11	On the unexposed surface, 12 in. from penetrant.

USNC142
ILL. 46

US COAST GUARD D8/A0
6-6-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	94.7	91.7	91.5	91.4
4	182.0	103.7	96.1	92.5
8	344.8	168.2	126.2	105.1
12	514.4	278.5	191.2	138.2
16	641.8	405.7	272.5	187.4
20	735.0	484.3	354.4	243.4
24	804.9	594.4	426.3	297.1
28	861.8	672.3	488.2	347.3
32	901.4	719.5	535.9	390.2
36	938.5	763.5	576.9	427.6
40	966.1	793.2	607.7	457.6
44	989.8	819.9	633.3	482.2
48	1007.1	836.8	649.2	500.2
52	1024.0	857.5	667.3	517.0
56	1039.0	877.5	681.4	531.9
60	1051.6	896.3	692.2	543.4

US COAST GUARD D8/A0
6-6-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

5

6

7

8

TIME
(MIN'S)

0	91.3	100.7	102.4	102.8
4	92.8	314.8	357.8	423.6
8	98.6	610.2	712.8	896.0
12	116.8	812.2	898.4	1069.8
16	145.5	930.0	1004.4	1135.9
20	182.3	1009.5	1071.2	1184.4
24	220.4	1073.1	1131.6	1223.0
28	259.6	1120.0	1173.8	1264.4
32	296.2	1161.8	1216.5	1304.5
36	329.6	1197.9	1253.4	1338.2
40	357.3	1229.2	1288.5	1369.4
44	381.7	1254.1	1313.8	1392.2
48	399.6	1277.9	1340.7	1412.0
52	417.1	1296.1	1361.7	1427.9
56	432.9	1311.8	1379.7	1442.5
60	445.5	1327.4	1397.3	1454.3

US COAST GUARD DS/AO
6-6-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11
TIME			
(MIN'S)			
0	105.1	107.1	106.1
4	422.6	386.8	404.9
8	855.9	761.0	773.1
12	1019.9	950.5	951.9
16	1094.2	1037.9	1051.7
20	1143.8	1088.1	1107.0
24	1190.3	1130.3	1154.7
28	1225.8	1171.0	1194.5
32	1265.6	1213.9	1233.8
36	1296.6	1250.0	1270.4
40	1323.5	1281.8	1302.8
44	1347.3	1306.0	1326.9
48	1376.5	1328.4	1353.3
52	1391.9	1352.3	1368.4
56	1406.4	1373.3	1383.4
60	1419.8	1390.6	1396.8

T E S T R E C O R D D8/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D8/A60 and as shown in ILL. 48.

The fire and hose stream tests were conducted on June 18, 1984.

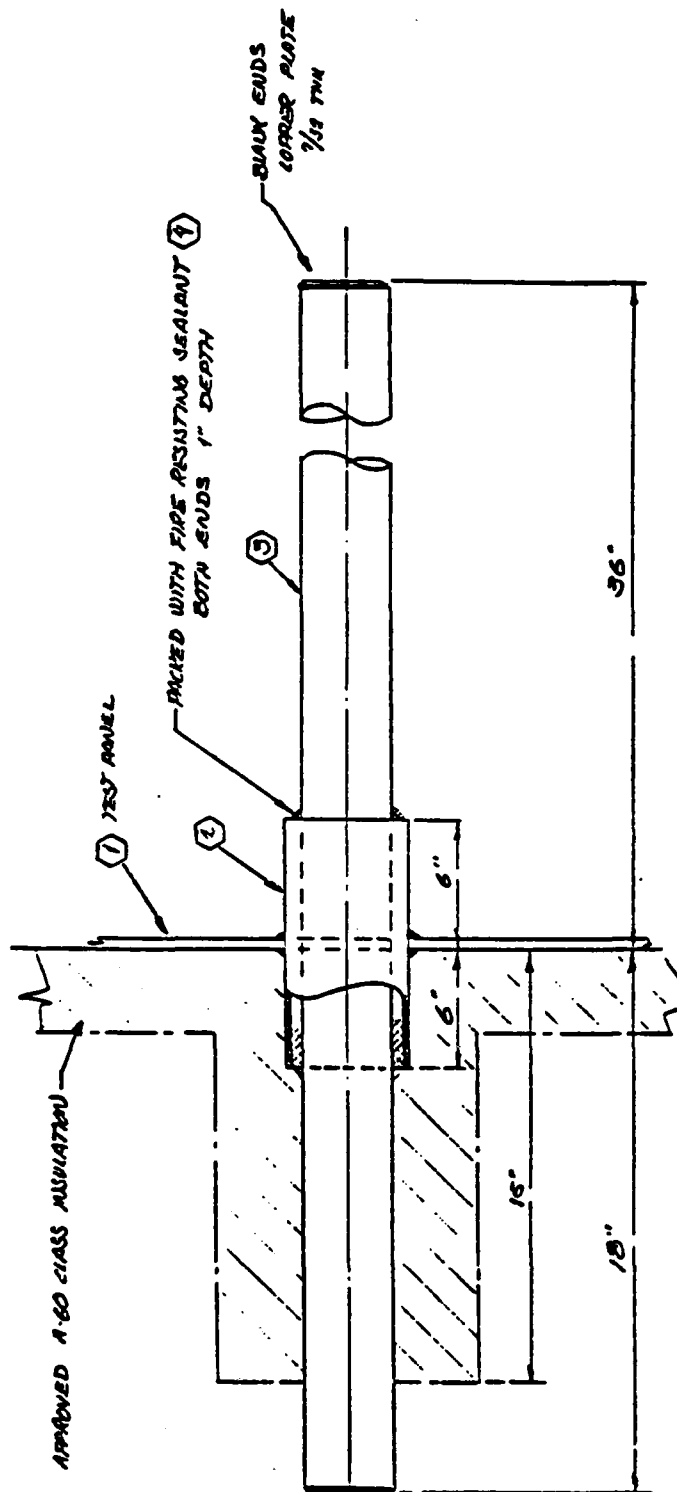
RESULTS

Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 49.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 50 through 50B.

Pictorial History - Photographs were obtained during the fire test. Because the penetrant had collapsed during the fire test, the hose stream test was not conducted.



ASSEMBLY D-8/A60
JUNE 18, 1984

① STEEL PLATE $\frac{3}{16}$ " THK. ASTM A-53
GRADE A OR B

② 1" SCH 40. SEAMLESS STEEL PIPE. ASTM A-53
GRADE A OR B

③ 3" PENUMAR CORNER PIPE ASTM B-42

④ FIRE SEALANT

PENETRATION NO D-8

(STEEL JOINT & CAPING)

FILE:	DECK	DATE:	7/8
FILE:	PENETRATION	DATE:	
FILE:		DATE:	
FILE:		DATE:	

USNC142

ILL. 46

SAMPLE D-8/A60
TEST DATE JUNE 18, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 12 in. above unexposed surface.
4	On penetrant, 18 in. above unexposed surface.
5	On penetrant, 24 in. above unexposed surface.
6	Interface of penetrant and unexposed surface.
7	On unexposed surface, 1 in. from penetrant.
8	On unexposed surface, 6 in. from penetrant.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 12 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 49

US COAST GUARD D8/A60
6-18-81
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	85.5	85.4	85.6	85.0
4	85.9	86.3	86.2	86.5
8	86.0	91.8	88.6	87.5
12	89.0	103.8	94.3	90.3
16	95.0	124.9	106.8	94.9
20	104.8	151.9	124.0	103.9
24	118.5	181.3	144.5	115.3
28	136.4	213.3	166.1	128.9
32	156.1	242.6	188.4	144.0
36	176.9	270.6	210.4	159.3
40	200.3	298.6	232.5	175.1
44	219.7	325.9	253.3	189.5
48	243.7	352.8	275.1	205.7
52	269.1	379.1	296.1	222.3
56	292.4	402.2	315.3	235.6
60	314.6	424.5	334.4	249.9

US COAST GUARD D8/A60
6-18-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	86.1	85.0	86.1	87.3
4	86.5	86.2	86.4	87.4
8	87.1	87.3	87.5	89.3
12	88.5	90.1	90.1	92.2
16	91.4	94.6	93.8	96.6
20	95.4	103.6	101.7	106.2
24	102.4	115.4	112.2	120.0
28	111.4	131.8	126.2	134.6
32	122.1	149.4	141.8	148.2
36	133.3	169.3	158.3	164.9
40	145.7	189.3	178.1	181.6
44	157.6	217.2	199.1	196.8
48	170.8	243.9	221.3	210.9
52	184.8	270.8	243.2	223.7
56	196.8	295.7	264.4	236.1
60	209.2	295.7	284.0	247.7

US COAST GUARD IS/A60
6-18-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

9

10

11

TIME
(MIN'S)

0	86.9	86.6	86.0
4	87.5	87.3	87.4
8	90.4	89.6	89.7
12	93.3	92.9	92.9
16	100.3	97.3	97.1
20	112.5	106.5	105.7
24	129.2	118.8	116.8
28	146.3	132.9	129.1
32	162.8	146.5	141.0
36	173.2	162.4	154.7
40	187.8	178.6	168.2
44	200.9	193.8	179.9
48	213.0	207.8	191.6
52	224.3	221.4	202.7
56	234.9	234.2	212.7
60	244.8	245.6	221.8

T E S T R E C O R D D9/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D9/A0 and as shown in ILL. 51.

The fire and hose stream tests were conducted on July 18, 1984.

RESULTS

Observations During Fire Test - By 45 min, the unexposed surface of the deck was glowing red.

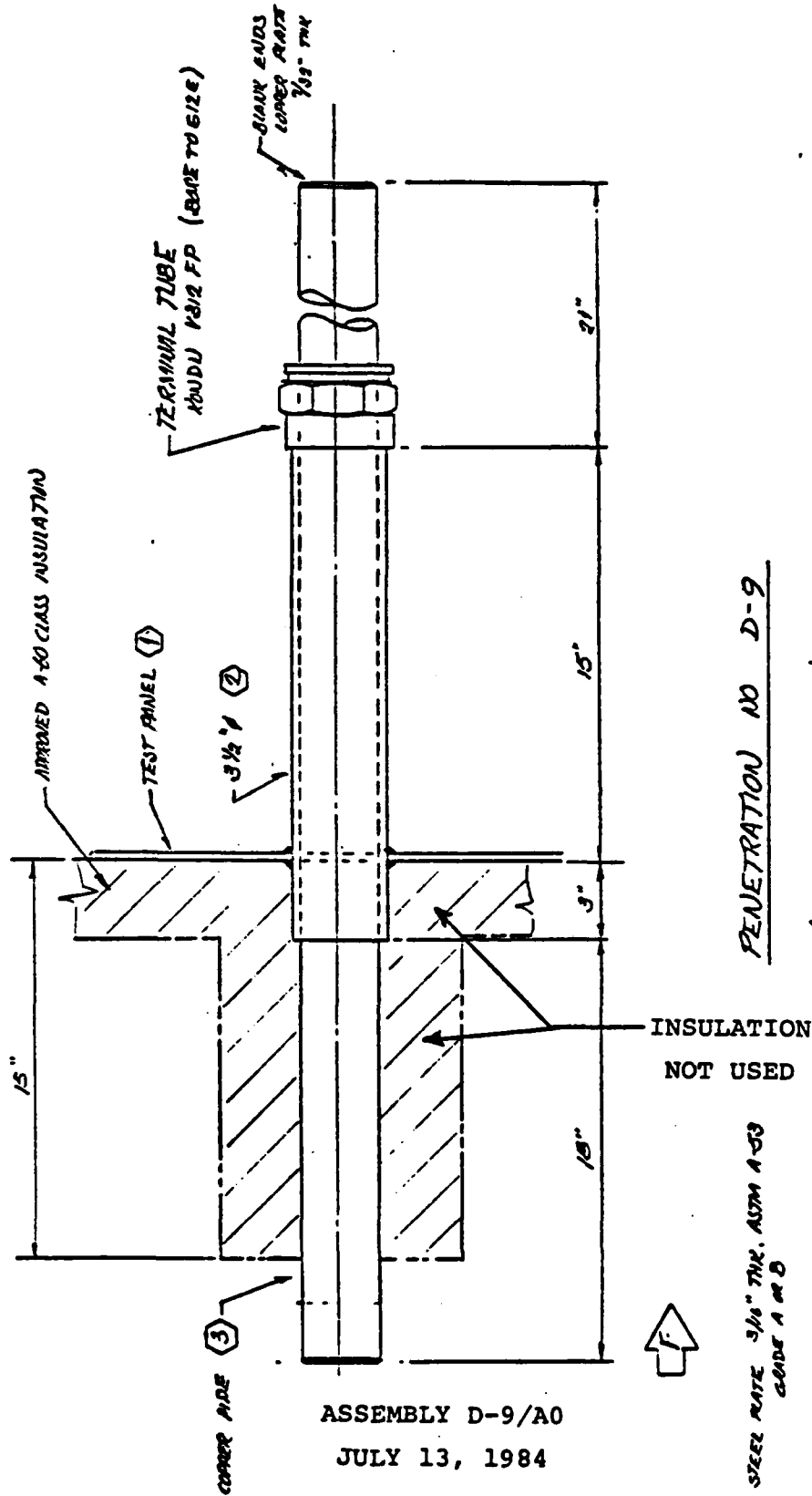
No significant changes occurred during the remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 52.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 53 through 53B.

Pressure Differential - The pressure differential recorded during the fire test is shown on ILL. 54.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-9/A0
JULY 13, 1984

PENETRATION NO D-9

(STEEL SPOT AND COPPER)

- ① STEEL RATE 3/16" THK. ASTM A 53
GRADE A OR B
- ② 3 1/2" SEAMLESS STEEL PIPE ASTM A 53
GRADE A OR B
- ③ 3" REGULAR COPPER PIPE ASTM B 62

FILE:	DECK
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	
DATE:	
FILE:	
NO. 84	
DATE: 8/13	
SCALE:	
BY:	
CHKD:	
APP'D:	

SAMPLE D-9/AO
TEST DATE JULY 18, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 12 in. above unexposed surface.
4	On penetrant's terminal tube.
5	On penetrant, at interface of steel pipe and copper pipe.
6	On penetrant, 24 in. above unexposed surface.
7	On unexposed surface, at interface of penetrant and unexposed surface.
8	On unexposed surface, 6 in. from penetrant.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 12 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 52

US COAST GUARD D9/A0
7-18-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	75.40	70.70	73.60	73.40
4	165.40	69.50	78.20	75.60
8	297.30	131.60	93.80	83.30
12	433.60	209.60	125.30	100.90
16	560.30	298.70	170.10	129.50
20	651.40	383.20	219.60	166.20
24	718.90	460.20	270.80	207.70
28	781.80	529.30	317.70	248.60
32	832.60	590.20	362.20	288.70
36	869.30	628.90	398.90	324.50
40	902.40	665.30	431.50	355.50
44	929.90	692.30	461.00	394.90
48	954.70	716.10	482.70	407.60
52	976.80	739.40	503.30	428.80
56	995.30	756.30	520.40	446.80
60	1010.40	772.50	535.40	462.30

US COAST GUARD D9/A0
7-18-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

5

6

7

8

TIME
(MIN'S)

0	73.40	73.30	76.60	78.20
4	75.10	74.90	244.80	287.70
8	82.00	79.40	474.40	522.30
12	97.70	89.90	663.70	709.10
16	123.70	107.70	809.40	849.60
20	157.20	131.30	895.40	933.60
24	195.80	159.60	965.30	997.50
28	234.50	189.30	1031.80	1052.20
32	273.00	220.60	1078.20	1089.80
36	306.70	249.20	1116.60	1124.30
40	337.00	275.90	1143.20	1153.80
44	364.70	301.20	1179.00	1189.70
48	386.80	321.50	1207.50	1216.20
52	406.80	340.30	1231.80	1240.50
56	424.00	356.30	1253.80	1258.40
60	439.10	370.60	1273.40	1277.00

US COAST GUARD D9/A0
7-18-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

9

10

11

TIME
(MIN'S)

0	76.10	71.90	73.10
4	223.00	319.70	343.40
8	335.80	626.00	643.00
12	791.10	852.10	851.10
16	937.40	960.00	952.00
20	1000.40	1027.70	1013.30
24	1061.80	1084.10	1064.60
28	1116.30	1141.00	1119.00
32	1151.10	1177.80	1152.40
36	1184.60	1211.10	1182.10
40	1207.30	1233.90	1205.80
44	1238.60	1264.60	1238.90
48	1257.60	1288.10	1263.20
52	1279.40	1304.90	1282.00
56	1295.60	1322.50	1299.10
60	1309.50	1338.40	1312.60

SAMPLE D-9/A0

TEST DATE JULY 18, 1984

PRESSURE DIFFERENTIAL

Time (Min's)	mm/Hg
0	-.002
4	.008
8	.012
12	.023
16	.019
20	.022
24	.023
28	.021
32	.024
36	.025
40	.027
44	.024
48	.024
52	.026
56	.026
60	.027

T E S T R E C O R D D9/A60

SAMPLE:

The fire test was conducted on the assembly identified as D9/A60 and as shown in ILL. 55.

The fire test was conducted on July 19, 1984.

RESULTS

Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 56.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 57 through 57B.

Pressure Differential - The pressure measurements recorded during the fire test are shown on ILL. 58.

Hose Stream Test - Due to a malfunction of the hose stream test equipment, a hose stream test was not conducted on the assembly.

Pictorial History - Photographs were obtained during and after the fire test.

SAMPLE D-9/A60
TEST DATE JULY 19, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 12 in. above unexposed surface.
4	On penetrant's terminal tube.
5	On penetrant, at interface of steel pipe and copper pipe.
6	On penetrant, 24 in. above unexposed surface.
7	On unexposed surface, at interface of penetrant and unexposed surface.
8	On unexposed surface, 1 in. from penetrant.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 6 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.
12	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 56

US COAST GUARD D9/A60
7-19-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	83.7	82.7	83.9	84.2
4	84.3	82.3	84.3	84.5
8	86.7	82.3	85.0	85.0
12	92.4	83.8	86.7	86.3
16	102.6	94.8	90.4	88.9
20	116.9	102.5	95.8	92.8
24	135.8	119.2	103.7	98.8
28	159.0	136.8	114.2	107.0
32	183.9	156.0	125.6	116.3
36	211.2	176.1	139.3	127.4
40	239.4	198.4	153.3	138.7
44	266.7	218.9	167.7	151.2
48	293.7	240.9	182.9	164.6
52	318.6	260.7	197.4	177.7
56	340.7	278.4	210.6	190.5
60	361.4	295.4	224.3	203.2

US COAST GUARD L97A60
7-19-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	83.8	84.3	84.2	85.4
4	84.2	84.5	84.7	85.8
8	84.9	85.0	86.8	87.4
12	86.6	86.1	91.8	91.5
16	90.0	88.3	100.7	98.7
20	94.9	91.3	113.3	109.2
24	102.0	96.0	130.2	123.7
28	110.8	102.1	151.1	141.8
32	120.9	109.4	174.7	162.7
36	132.4	117.8	199.9	187.2
40	144.3	126.9	227.1	213.0
44	157.1	136.8	254.1	238.8
48	170.6	147.6	279.5	263.3
52	183.8	158.3	304.1	286.6
56	196.8	169.2	326.3	307.4
60	210.1	180.3	345.6	326.4

US COAST GUARD D9/A60
7-19-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
0	85.4	79.6	81.0	79.4
4	86.4	80.1	82.7	80.2
8	88.4	81.7	85.2	82.4
12	91.6	84.9	88.7	86.0
16	96.6	90.4	93.8	92.1
20	104.1	99.4	101.1	101.4
24	115.0	112.5	112.5	114.7
28	128.7	128.2	123.0	129.8
32	143.2	144.8	135.8	144.9
36	160.9	165.3	150.5	162.7
40	180.0	187.0	165.9	180.3
44	198.1	208.4	180.0	196.8
48	214.2	227.8	192.9	212.1
52	228.6	245.6	204.7	226.9
56	242.1	261.7	214.8	240.0
60	254.2	276.0	224.5	251.8

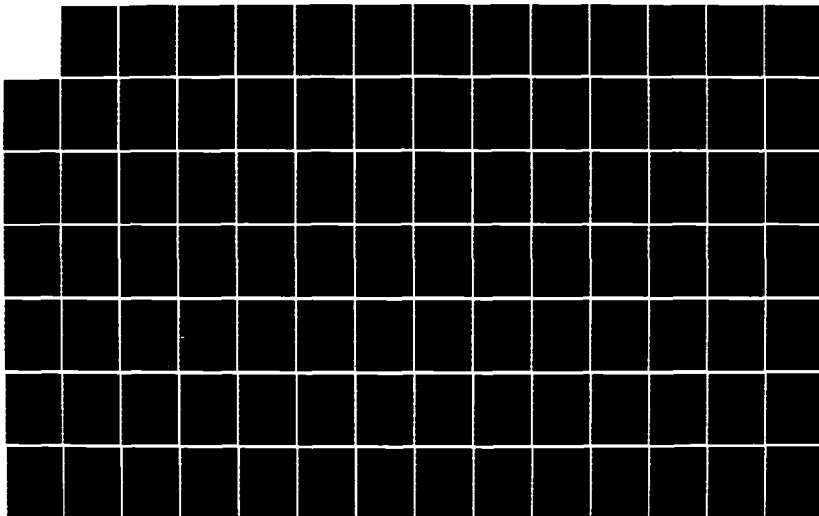
AD-A163 315

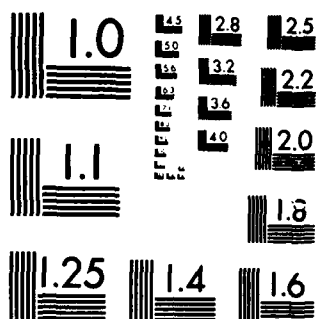
FIRE RESISTANCE TESTING OF BULKHEAD AND DECK
PENETRATIONS(U) COAST GUARD RESEARCH AND DEVELOPMENT
CENTER GROTON CT D E BEENE ET AL. OCT 85 CGR/DC-5/85
UNCLASSIFIED USCG-D-33-85

3/4

F/G 13/12

NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

SAMPLE D-9/A60

TEST DATE D-9/A60

PRESSURE DIFFERENTIAL

Time (Min's)	mm/Hg
0	-.002
4	.000
8	.012
12	.013
16	.014
20	.014
24	.016
28	.017
32	.019
36	.021
40	.022
44	.022
48	.023
52	.024
56	.024
60	.025

T E S T R E C O R D D10/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D10/A0 and as shown in ILL. 59.

The fire and hose stream tests were conducted on July 19, 1984.

RESULTS

Observations During Fire Test - By 40 min, the unexposed surface of the deck was glowing red.

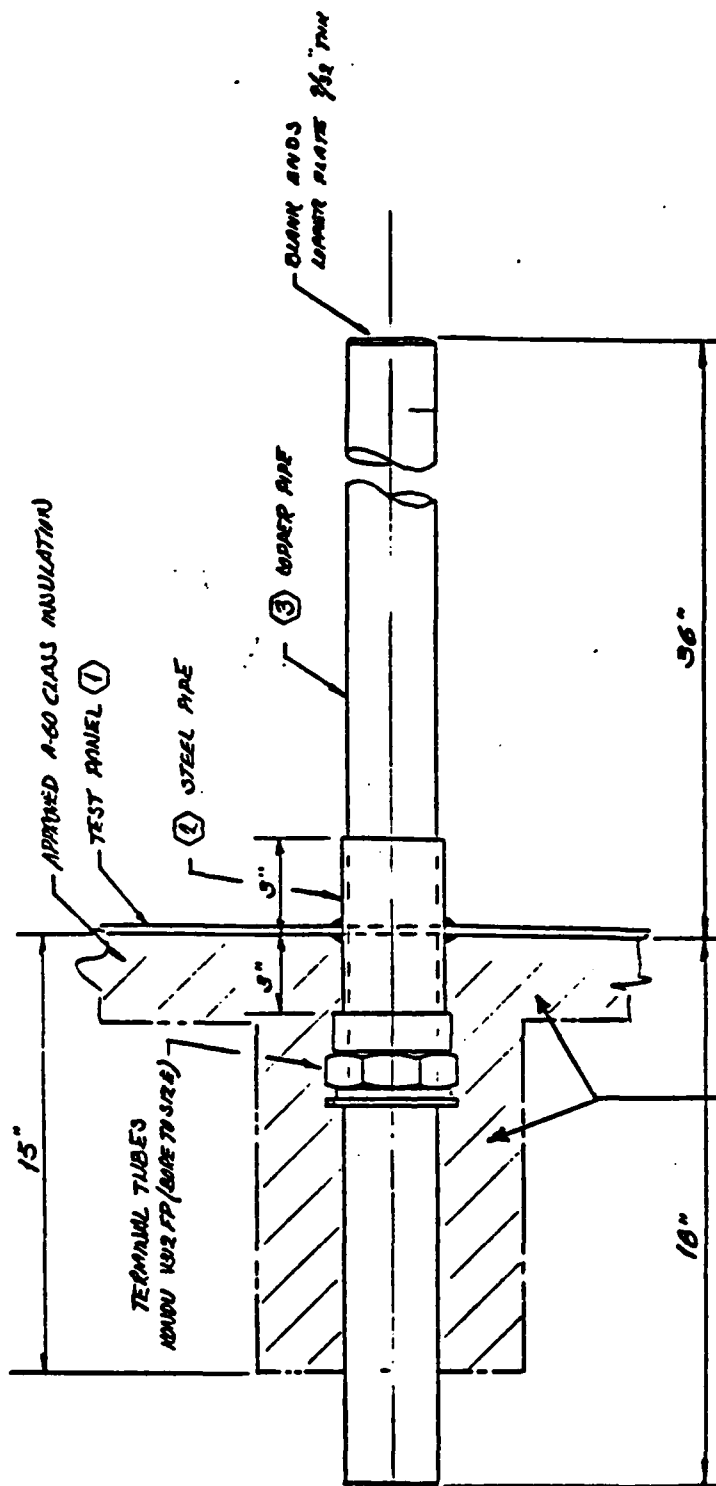
No significant changes occurred during the remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 60.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 61 through 61C.

Pressure Differential - The pressure measurements recorded during the fire test are shown on ILL. 62.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-10/A0
JULY 19, 1984

- ① STEEL PLATE 1/4" THK ASTM A-53
GRADE A AND B
- ② 3 1/2" ODN NO SEAMLESS STEEL PIPE
ASTM A-53 GRADE A AND B
- ③ 3" REGULAR CARBON PIPE, ASTM B-42

PENETRATION NO D-10

(COVER)

INSULATION
NOT USED

TITLE:	DECK
DATE:	17-10
BY:	USNC142
CHECKED BY:	
DATE:	

SAMPLE D-10/AO
TEST DATE JULY 19, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, at interface of steel pipe and copper pipe.
3	On penetrant, 6 in. above unexposed surface.
4	On penetrant, 12 in. above unexposed surface.
5	On penetrant, 18 in. above unexposed surface.
6	On penetrant, 24 in. above unexposed surface.
7	On unexposed surface, at interface of penetrant and unexposed surface.
8	On unexposed surface, 1 in. from penetrant.
9	On unexposed surface, 1 in. from penetrant.
10	On unexposed surface, 6 in. from penetrant.
11	On unexposed surface, 6 in. from penetrant.
12	On unexposed surface, 12 in. from penetrant.
13	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 60

US COAST GUARD D10/A0
7-19-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	77.2	74.9	76.4	76.0
4	167.6	113.2	100.2	82.4
8	310.9	204.8	165.8	112.4
12	457.9	309.3	266.4	172.2
16	593.3	449.0	390.6	256.2
20	688.9	571.0	503.2	339.5
24	757.6	670.1	602.7	416.7
28	818.5	746.8	668.8	479.3
32	874.0	809.8	728.5	533.7
36	917.2	855.1	773.4	577.5
40	947.7	889.6	805.5	609.3
44	969.5	915.4	831.9	636.3
48	988.3	938.6	853.8	656.6
52	1013.8	959.8	875.3	675.5
56	1027.2	977.2	892.1	691.7
60	1041.3	993.4	905.6	704.1

US COAST GUARD D10/A0
7-19-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	75.8	75.6	78.4	78.6
4	78.1	77.4	249.9	285.3
8	90.6	84.4	452.3	534.1
12	119.8	100.2	635.7	744.0
16	167.4	126.7	777.6	874.9
20	224.1	160.9	873.0	951.8
24	282.2	200.8	942.2	1014.8
28	333.3	238.7	1012.5	1083.3
32	379.7	277.3	1069.3	1134.8
36	419.8	311.2	1111.4	1172.0
40	451.5	339.3	1145.6	1206.0
44	479.4	365.1	1175.3	1235.0
48	500.3	384.6	1203.0	1267.5
52	518.7	403.8	1232.8	1295.4
56	533.9	417.0	1252.5	1311.8
60	546.7	429.7	1268.7	1328.6

US COAST GUARD D10/A0
7-19-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
0	78.4	73.4	72.5	73.3
4	275.4	387.0	324.0	340.2
8	491.7	688.1	583.0	652.4
12	672.9	881.3	777.7	851.1
16	808.2	976.4	879.3	956.9
20	887.4	1025.8	939.6	1012.7
24	948.0	1078.3	987.4	1068.1
28	1016.1	1139.4	1056.5	1129.7
32	1067.2	1180.5	1097.8	1172.9
36	1105.9	1213.8	1132.3	1207.6
40	1137.2	1243.2	1159.1	1238.4
44	1166.5	1269.7	1186.5	1264.0
48	1198.5	1299.9	1216.7	1297.0
52	1227.1	1326.1	1242.6	1321.7
56	1250.8	1344.3	1262.9	1340.6
60	1271.6	1360.0	1279.2	1357.6

US COAST GUARD D10/A0
7-19-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

13

TIME
(MIN'S)

0	73.3
4	310.7
8	568.6
12	779.8
16	869.7
20	922.8
24	960.2
28	1025.0
32	1062.7
36	1096.4
40	1125.4
44	1151.1
48	1181.1
52	1206.2
56	1227.9
60	1246.9

SAMPLE D-10/AO
TEST DATE JULY 19, 1984
PRESSURE DIFFERENTIAL

Time (Min's)	mm/Hg
0	-.002
4	.000
8	.002
12	.012
16	.013
20	.014
24	.015
28	.017
32	.019
36	.021
40	.022
44	.022
48	.023
52	.024
56	.025
60	.025

T E S T R E C O R D D10/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D10/A60 and as shown in ILL. 63.

The fire and hose stream tests were conducted on July 20, 1984.

RESULTS

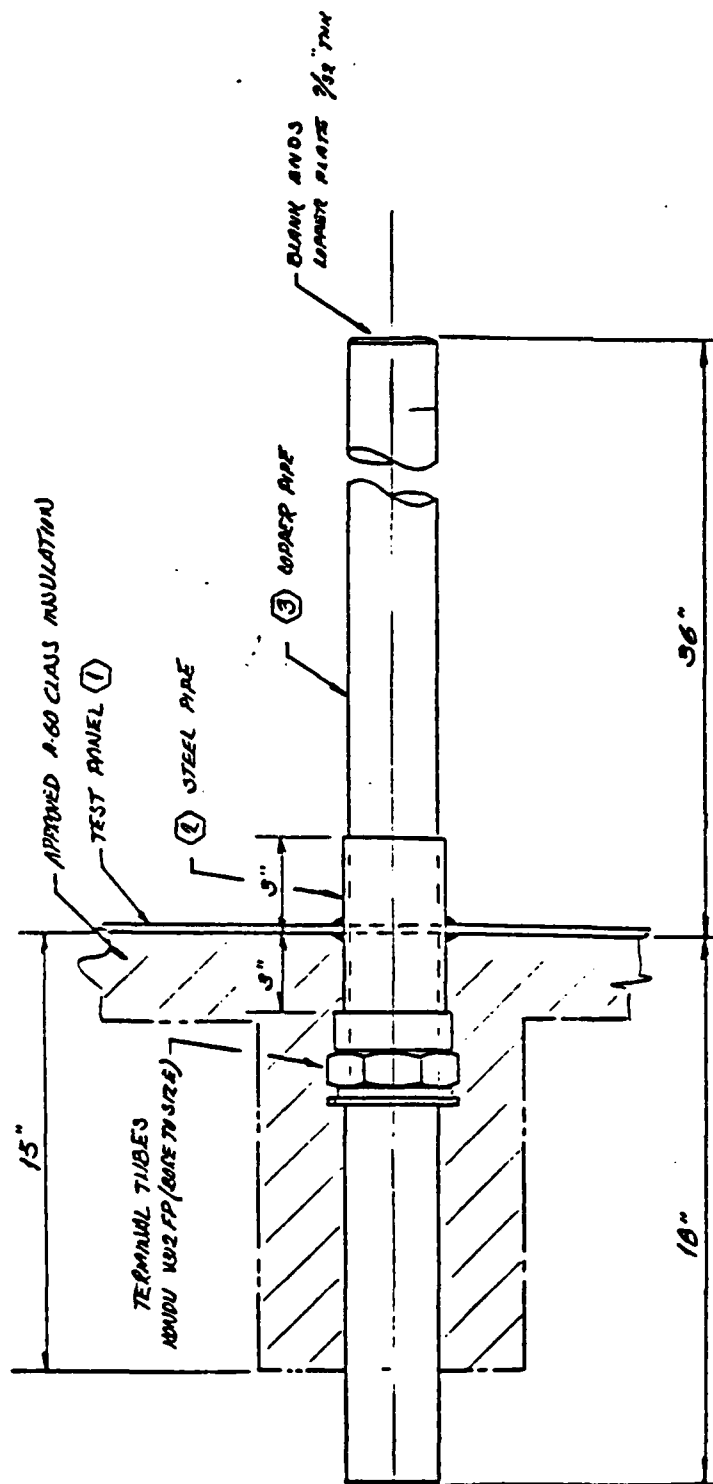
Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 64.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 65 through 65C.

Pressure Differential - The pressure measurements recorded during the fire test are shown on ILL. 66.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-10/A60
JULY 20, 1984



(1) STEEL PLATE 1/4" THK ASTM A-53
GRADE A OR B

(2) 3/2" SCH 40 SEAMLESS STEEL PIPE
ASTM A-53 GRADE A OR B

(3) 3" REGULAR COPPER PIPE, ASTM B-42

PENETRATION NO D-10

(COPPER)

DATE:	REV:
BY:	BY:
DATE:	DATE:
SCALE:	SCALE:
1"=1'-10"	1"=1'-10"

USNC142

SAMPLE D-10/A60
TEST DATE JULY 20, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, at interface of steel pipe and copper pipe.
3	On penetrant, 6 in. above unexposed surface.
4	On penetrant, 12 in. above unexposed surface.
5	On penetrant, 18 in. above unexposed surface.
6	On penetrant, 24 in. above unexposed surface.
7	On unexposed surface, at interface of penetrant and unexposed surface.
8	On unexposed surface, 1 in. from penetrant.
9	On unexposed surface, 1 in. from penetrant.
10	On unexposed surface, 6 in. from penetrant.
11	On unexposed surface, 6 in. from penetrant.
12	On unexposed surface, 12 in. from penetrant.
13	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 64

US COAST GUARD D10/A60
7-20-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	85.2	83.5	85.2	85.6
4	85.5	84.6	85.9	85.9
8	88.0	88.9	90.5	87.5
12	94.5	100.2	100.5	91.8
16	106.0	115.7	115.6	99.4
20	122.9	141.6	136.1	110.9
24	145.5	172.6	161.2	125.9
28	170.5	202.5	189.6	143.5
32	196.5	242.0	218.7	163.1
36	225.5	259.2	247.7	184.2
40	256.1	278.0	276.2	205.1
44	285.2	305.4	303.3	225.0
48	312.6	334.6	333.0	246.8
52	338.3	361.0	361.8	267.4
56	364.1	389.0	388.6	288.7
60	390.2	416.0	413.2	308.5

US COAST GUARD D10/A60
7-20-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	85.7	85.8	85.9	86.2
4	85.9	86.0	85.9	86.2
8	86.6	86.4	88.6	87.3
12	88.6	87.5	93.9	90.6
16	92.5	89.8	103.3	96.5
20	99.0	93.7	117.5	105.9
24	108.1	99.5	136.9	119.3
28	119.0	106.9	162.2	136.5
32	132.1	116.0	187.4	156.2
36	146.3	126.5	214.2	176.5
40	161.3	137.7	246.3	201.0
44	175.2	149.5	278.4	226.6
48	190.8	162.3	307.8	252.5
52	206.0	174.2	337.9	276.3
56	222.0	186.7	366.2	300.0
60	237.9	199.9	387.1	323.6

US COAST GUARD D10/A60
7-20-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
0	86.2	79.7	79.5	79.9
4	86.5	80.6	80.6	83.3
8	88.4	83.8	83.7	91.0
12	93.3	89.3	88.9	105.7
16	101.6	97.6	97.0	123.9
20	113.7	110.9	108.5	140.8
24	129.9	127.0	122.8	159.8
28	147.7	145.2	138.5	178.7
32	168.0	166.1	157.9	197.4
36	193.2	186.3	179.0	217.6
40	224.0	206.9	200.6	234.2
44	256.0	225.0	221.9	252.4
48	285.7	244.0	241.6	273.8
52	312.0	260.4	259.1	289.9
56	337.6	275.6	275.7	304.8
60	365.1	290.7	291.2	319.0

US COAST GUARD D10/A60
7-20-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

13

TIME
(MIN'S)

0	80.6
4	81.5
8	85.6
12	92.7
16	103.8
20	117.6
24	132.6
28	149.8
32	167.3
36	184.5
40	201.2
44	216.9
48	231.2
52	245.3
56	257.9
60	269.0

SAMPLE D-10/A60

TEST DATE JULY 20, 1984

PRESSURE DIFFERENTIAL

Time (Min's)	mm/Hg
0	-.002
4	.000
8	.014
12	.016
16	.018
20	.019
24	.019
28	.020
32	.022
36	.023
40	.024
44	.024
48	.023
52	.024
56	.025
60	.025

T E S T R E C O R D D11/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D11/A0 and as shown in ILL. 67.

The fire and hose stream tests were conducted on June 7, 1984.

RESULTS

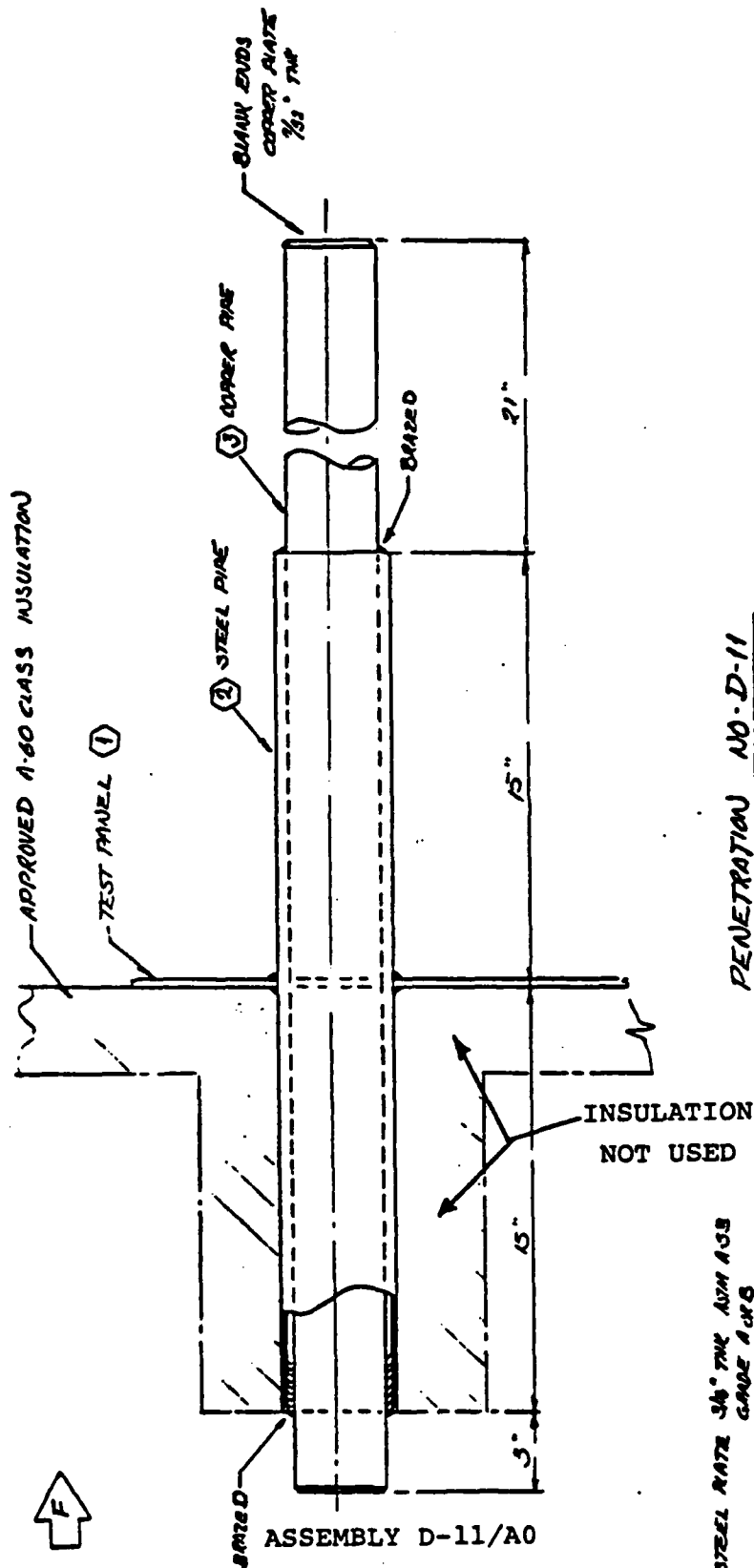
Observations During Fire Test - By 50 min, the unexposed surface of the deck was glowing red.

No significant changes occurred during the remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 68.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 69 through 69B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-11/A0

JUNE 7, 1984

PENETRATION NO-D-11

(STEEL JOINT & COVER)

(1) STEEL RATE 3/4" THK ASTM A36 GRADE A & B

(2) 5 1/2" SCH 40 STEEL PIPE ASTM A-53 GRADE A & B

(3) 3" LUMBER COVER PIPE ASTM A-53

DATE:	FEB 87
BY:	AS
NO:	1
REV:	

USNC142

ILL. 67

SAMPLE D-11/AO
TEST DATE JUNE 7, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 12 in. above unexposed surface.
4	On penetrant, at interface of steel pipe and copper pipe.
5	On penetrant, 18 in. above unexposed surface.
6	On penetrant, 24 in. above unexposed surface.
7	On unexposed surface, at interface of penetrant and unexposed surface.
8	On unexposed surface, 6 in. from penetrant.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 12 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 68

US COAST GUARD D11/A0
6-7-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	93.3	90.2	89.6	89.4
4	194.0	106.2	96.3	92.0
8	351.2	174.2	124.2	110.4
12	536.2	265.5	186.7	157.3
16	668.7	383.6	247.0	230.2
20	766.0	486.3	311.4	285.6
24	839.3	579.3	382.0	348.2
28	893.1	636.7	440.3	402.3
32	935.8	679.9	486.7	447.1
36	972.4	715.9	523.0	484.2
40	1001.3	746.0	555.9	515.7
44	1023.2	767.2	577.9	541.6
48	1038.3	782.6	594.4	561.7
52	1054.8	799.8	613.0	579.5
56	1072.4	816.8	628.1	595.2
60	1086.3	829.1	640.3	607.7

US COAST GUARD D11/A0
6-7-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	89.4	89.3	99.0	106.8
4	92.7	90.0	320.0	522.6
8	106.0	96.8	608.5	941.5
12	141.1	115.6	806.5	1068.2
16	195.6	145.5	929.6	1147.0
20	247.8	182.8	1008.4	1193.2
24	300.5	222.0	1068.1	1231.9
28	347.9	260.5	1120.9	1274.5
32	388.5	296.4	1167.2	1312.6
36	423.9	328.8	1208.4	1343.2
40	454.2	357.0	1240.3	1369.0
44	478.4	381.6	1262.0	1384.9
48	497.6	401.1	1282.4	1401.3
52	514.5	418.0	1303.8	1421.3
56	529.5	432.9	1324.4	1440.5
60	541.1	444.9	1340.8	1428.0

US COAST GUARD D11/A0
6-7-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

9

10

11

TIME
(MIN'S)

0	96.3	107.2	96.3
4	335.3	437.4	284.2
8	865.0	816.8	0.0
12	1048.2	968.8	972.7
16	1137.5	1057.5	1072.1
20	1186.1	1109.6	1122.3
24	1225.5	1152.0	1164.5
28	1264.1	1195.2	1201.9
32	1302.2	1234.5	1243.3
36	1334.1	1269.9	1281.7
40	1363.2	1298.1	1307.2
44	1377.6	1314.2	1321.5
48	1403.9	1330.6	1348.7
52	1424.0	1356.1	1371.0
56	1444.5	1378.5	1392.4
60	1457.7	1397.6	1406.3

T E S T R E C O R D D11/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D11/A60 and as shown in ILL. 70.

The fire and hose stream tests were conducted on July 5, 1984.

RESULTS

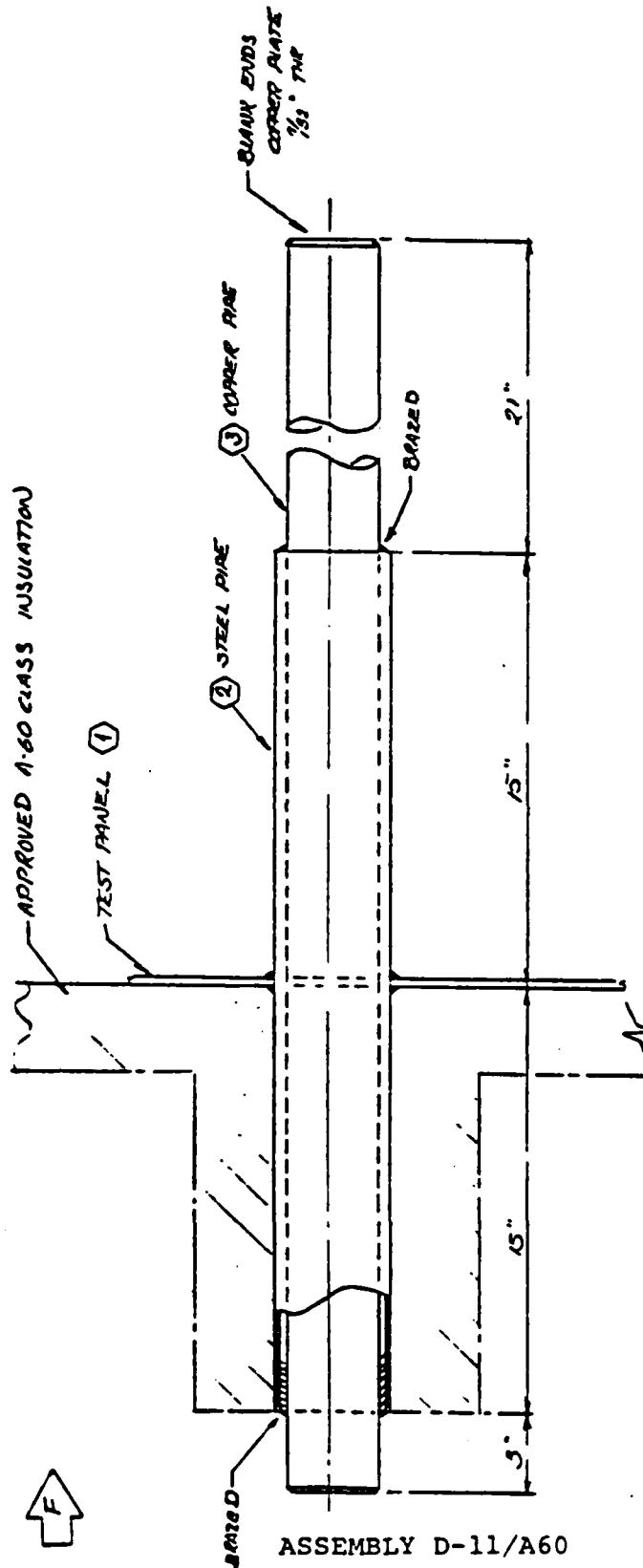
Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 71.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 72 through 72B.

Pressure Differential - The pressure measurements recorded during the fire test are shown on ILL. 73.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-11/A60
JULY 5, 1984

- ① STEEL RATE $3/4"$ THK ASTM A53
GRADE A X 8
- ② $3\frac{1}{2}"$ SCH 40, STEEL PIPE ASTM A-53
GRADE A X 8
- ③ 3" LEXAN COPPER PIPE ASTM A-53

PENETRATION NO-D-11
(STEEL JOINT & COPPER)

TITLE: <u>DECK</u>	DATE: <u>FEB 87</u>
<u>PENETRATION</u>	APPROVED BY: <u>MS</u>
	SCALE: <u>---</u>
DWG. NO. <u>D-11</u>	REV: <u>---</u>

SAMPLE D-11/A60
TEST DATE JULY 5, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 12 in. above unexposed surface.
4	On penetrant, at interface of steel pipe and copper pipe.
5	On penetrant, 18 in. above unexposed surface.
6	On penetrant, 24 in. above unexposed surface.
7	On unexposed surface, at interface of penetrant and unexposed surface.
8	On unexposed surface, 6 in. from penetrant.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 12 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 71

US COAST GUARD D11/A60
7-5-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

TIME
(MIN'S)

	1	2	3	4
0	80.70	76.70	81.0	81.30
4	81.10	78.00	81.2	81.70
8	84.20	79.40	81.8	82.60
12	91.60	83.10	83.7	85.20
16	104.40	89.10	87.6	89.90
20	122.60	100.40	93.9	97.00
24	145.00	117.70	102.8	106.40
28	169.70	134.80	113.9	117.80
32	196.20	153.30	126.7	130.50
36	224.60	172.30	140.0	144.40
40	251.40	193.80	155.6	159.50
44	28.30	216.90	171.5	175.10
48	309.10	238.50	186.8	190.50
52	336.40	257.10	204.2	206.70
56	365.90	277.80	220.1	220.90
60	391.10	295.30	234.2	234.40

US COAST GUARD D11/A60
7-5-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

5

6

7

8

TIME
(MIN'S)

0	81.20	81.30	81.4	81.50
4	81.50	81.50	81.7	82.20
8	82.20	81.90	84.3	84.90
12	84.30	83.00	90.7	90.20
16	88.30	85.20	102.1	101.20
20	94.50	88.90	118.7	117.80
24	102.90	94.10	140.0	136.30
28	113.10	101.00	163.7	153.50
32	124.70	109.20	189.0	173.70
36	137.40	118.60	217.5	194.20
40	151.10	128.70	245.0	213.90
44	165.70	140.00	272.3	232.00
48	180.30	151.90	300.8	248.10
52	195.40	164.20	328.8	263.50
56	209.40	176.00	356.3	277.80
60	222.60	187.00	383.0	290.30

US COAST GUARD D11/A60
7-5-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11
TIME (MIN'S)			
0	81.30	75.50	74.9
4	81.90	75.60	75.4
8	84.10	78.30	77.5
12	87.70	83.50	80.8
16	94.90	94.10	87.1
20	107.00	109.70	97.7
24	122.60	125.80	111.1
28	138.00	140.80	124.4
32	153.60	157.30	136.7
36	171.50	173.50	151.1
40	188.90	189.00	165.3
44	205.50	203.30	178.7
48	221.10	216.50	191.3
52	235.60	229.30	203.4
56	250.70	241.50	214.9
60	263.70	252.30	225.8

SAMPLE D-11/A60

TEST DATE JULY 5, 1984

PRESSURE DIFFERENTIAL

Time (Min's)	mm/Hg
0	-.002
4	.002
8	.013
12	.017
16	.018
20	.019
24	.020
28	.020
32	.022
36	.023
40	.023
44	.024
48	.024
52	.024
56	.025
60	.025

T E S T R E C O R D D12/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D12/A0 and as shown in ILL. 74.

The fire and hose stream tests were conducted on June 6, 1984.

RESULTS

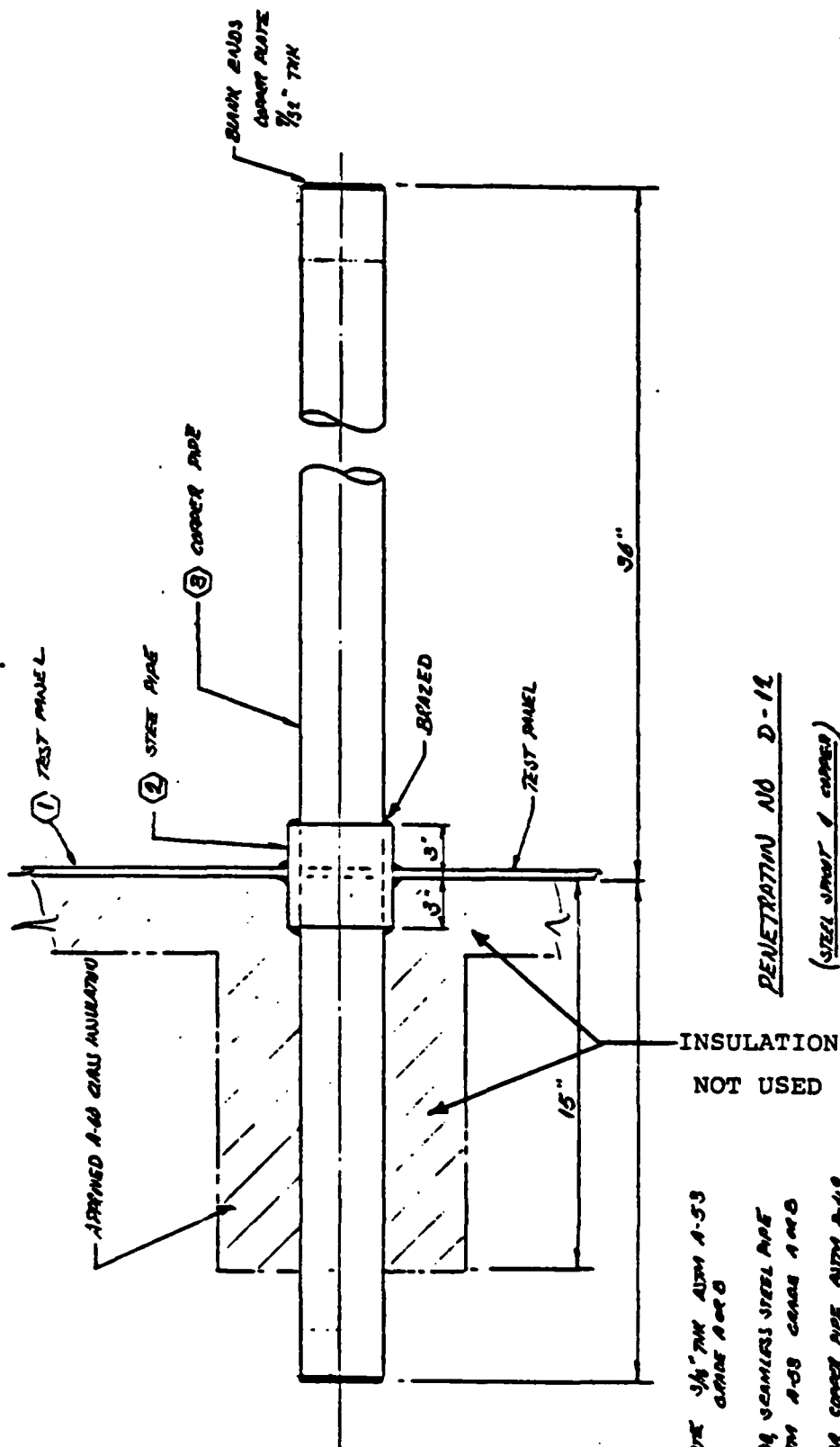
Observations During Fire Test - By 40 min, the unexposed surface of the deck was glowing red.

No significant changes occurred during the remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 75.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 76 through 76B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-12/A0

JUNE 6, 1984

1 STEEL NAME 3/4" THK ALUM A-53
GRADE A 900

⑦ 3 1/2" SEAMLESS STEEL PIPE
WITH ASS GRADE 1000

⑤ 1" SQUARE CORNER NPS WITH 8-42

FILE:	DECK	DATE:	NOV 64
PENETRATION		TIME:	7:18
PLUG NO:	D-134	REV:	

SAMPLE D-12/AO
TEST DATE JUNE 6, 1984

<u>T.C.</u>	<u>Location</u>
1	On unexposed surface, at interface of penetrant and unexposed surface.
2	On penetrant, 1 in. above unexposed surface.
3	On penetrant, at interface of steel pipe and copper pipe.
4	On penetrant, 6 in. above unexposed surface.
5	On penetrant, 12 in. above unexposed surface.
6	On penetrant, 18 in. above unexposed surface.
7	On penetrant, 24 in. above unexposed surface.
8	On unexposed surface, 1 in. from penetrant.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 6 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 75

US COAST GUARD D12/A0
6-6-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	90.6	87.9	86.0	86.4
4	311.4	192.1	156.2	124.2
8	624.5	376.8	315.2	235.6
12	846.2	592.3	515.5	394.3
16	971.0	746.6	685.9	536.9
20	1043.9	845.6	776.8	639.5
24	1094.6	904.0	839.4	701.6
28	1139.5	946.9	884.8	748.0
32	1178.8	981.0	919.2	783.3
36	1177.1	1009.0	948.3	812.7
40	1204.9	1033.3	972.1	835.4
44	1227.0	1051.3	990.5	854.2
48	1246.5	1067.3	1006.3	871.5
52	1260.3	1080.5	1019.7	883.2
56	1278.2	1088.3	1026.1	890.4
60	1289.5	1102.2	1040.8	902.0

US COAST GUARD D12/A0
6-6-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	87.9	85.4	85.3	93.3
4	88.6	88.9	86.9	357.7
8	90.0	106.5	93.9	720.4
12	228.2	149.2	116.1	917.1
16	322.5	206.1	150.0	1017.8
20	405.0	265.4	190.9	1071.0
24	469.2	319.7	233.7	1109.9
28	516.6	363.7	272.1	1154.1
32	551.0	398.0	304.3	1195.4
36	582.5	429.5	334.3	1232.8
40	604.7	453.7	358.2	1265.3
44	623.7	474.4	379.8	1289.1
48	640.0	492.1	398.1	1309.7
52	651.7	505.5	412.7	1325.6
56	658.4	514.1	422.0	1344.2
60	669.7	524.9	433.2	1356.2

US COAST GUARD D12/A0
6-6-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

9

10

11

TIME
(MIN'S)

0	93.3	92.3	
4	370.4	380.6	405.4
8	726.5	764.8	886.2
12	936.6	944.5	1031.0
16	1033.9	1034.8	1113.6
20	1088.2	1086.6	1161.4
24	1128.1	1124.3	1192.5
28	1171.8	1165.7	1231.5
32	1211.7	1209.9	1262.4
36	1243.7	1240.9	1288.2
40	1273.7	1273.4	1315.4
44	1296.6	1296.5	1335.6
48	1313.6	1318.6	1352.5
52	1325.8	1332.5	1365.9
56	1346.5	1350.8	1383.5
60	1361.4	1363.8	1398.9

T E S T R E C O R D D12/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D12/A60 and as shown in ILL. 77.

The fire and hose stream tests were conducted on July 16, 1984.

RESULTS

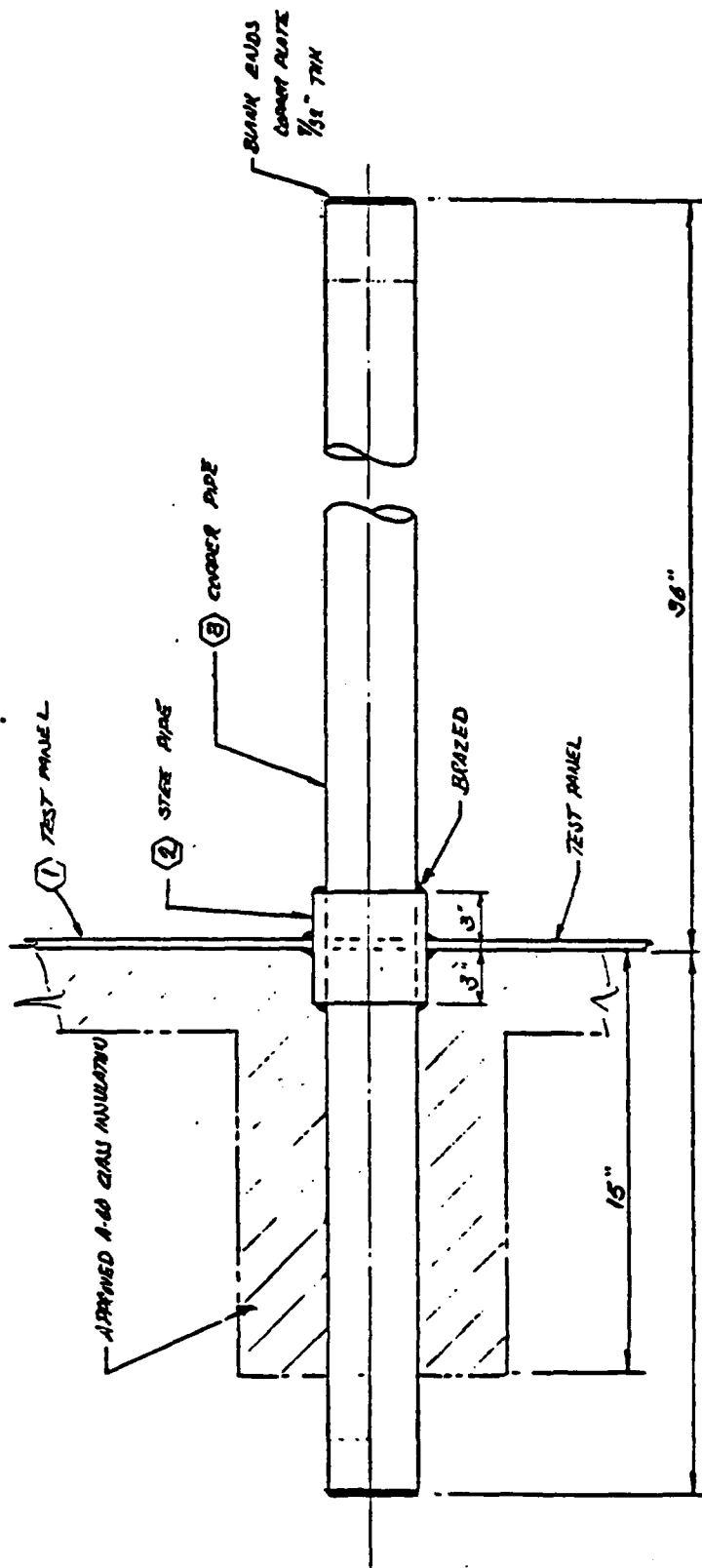
Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 78.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 79 through 79B.

Pressure Differential - The pressure measurements recorded during the fire test are shown on ILL. 80.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-12/A60

JULY 16, 1984



C-168

① STEEL PIPE 3/4" DIA. AUTH A-53
GRADE A OR B

② 3/4" SCH 40 SEAMLESS STEEL PIPE
AUTH A-53 GRADE A OR B

③ 4" BRASS CORNER PIPE AUTH B-48

PENETRATION NO D-12

(STEEL JOINT & CORNER)

TITLE:	DECK
DATE:	FEB 84
BY:	708
SCALE:	
REV:	
PLUG NO:	D-12

USNC142

ILL. 77

SAMPLE D-12/A60
TEST DATE JULY 16, 1984

<u>T.C.</u>	<u>Location</u>
1	On unexposed surface, at interface of penetrant and unexposed surface.
2	On penetrant, 1 in. above unexposed surface.
3	On penetrant, at interface of steel pipe and copper pipe.
4	On penetrant, 6 in. above unexposed surface.
5	On penetrant, 12 in. above unexposed surface.
6	On penetrant, 18 in. above unexposed surface.
7	On penetrant, 24 in. above unexposed surface.
8	On unexposed surface, 6 in. from penetrant.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 12 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 78

US COAST GUARD
SMALL SCALE D12/A60

7-16-84

CHAN(NOS.)	1	2	3	4
TIME				
0: 5	87.1	85.8	85.5	85.4
4: 4	87.9	86.6	86.5	86.1
8: 4	93.5	92.8	93.6	91.3
12: 4	106.5	106.9	108.0	102.3
16: 4	126.5	128.6	129.3	119.0
20: 4	152.8	157.1	157.8	141.8
24: 4	187.0	192.3	192.5	169.8
28: 4	227.6	233.5	231.8	201.8
32: 4	267.2	275.2	272.2	235.1
36: 4	299.7	315.5	311.7	268.3
40: 4	334.8	354.0	348.5	300.6
44: 4	365.2	388.5	381.2	328.0
48: 4	384.2	419.7	411.1	354.2
52: 4	405.7	445.8	435.7	376.1
56: 4	429.1	471.6	461.3	398.2
60: 4	446.2	493.7	482.2	417.7

U.S. COAST GUARD
SMALL SCALE D12/A60

7-16-84

CHAN(NOS.)	5	6	7	8
TIME				
0: 5	85.3	85.0	85.1	91.3
4: 4	85.5	85.3	85.3	93.3
8: 4	87.4	86.0	85.8	99.6
12: 4	91.6	87.9	86.8	113.3
16: 4	99.0	91.4	88.4	131.0
20: 4	110.6	97.4	91.5	150.5
24: 4	125.8	106.0	96.6	171.3
28: 4	144.3	117.0	103.3	192.1
32: 4	164.1	129.8	111.5	211.1
36: 4	186.1	144.3	121.5	228.3
40: 4	209.6	160.3	132.6	245.3
44: 4	230.6	175.1	144.1	259.8
48: 4	251.0	190.8	156.8	273.7
52: 4	267.7	204.5	168.0	285.2
56: 4	286.1	219.1	180.1	296.2
60: 4	302.2	231.8	190.8	306.1

US COAST GUARD
SMALL SCALE D12/A60

7-16-84

CHAN(NOS.) TIME	9	10	11
0: 5	90.3	83.3	83.0
4: 4	91.0	84.0	83.5
8: 4	93.9	89.5	87.5
12: 4	100.5	104.9	100.0
16: 4	112.5	126.0	119.6
20: 4	128.5	148.8	141.8
24: 4	146.6	174.1	169.6
28: 4	168.3	199.0	196.1
32: 4	189.0	222.1	222.1
36: 4	207.5	243.6	246.1
40: 4	224.6	263.7	266.8
44: 4	241.6	281.8	285.7
48: 4	255.8	298.1	302.8
52: 4	268.2	312.1	317.0
56: 4	280.1	324.6	329.5
60: 4	289.8	335.8	340.7

SAMPLE D-12/A60

TEST DATE JULY 16, 1984

PRESSURE DIFFERENTIAL

Time (Min's)	mm/Hg
0	-.002
4	.002
8	.013
12	.014
16	.016
20	.016
24	.019
28	.019
32	.019
36	.020
40	.020
44	.020
48	.020
52	.021
56	.021
60	.020

T E S T R E C O R D D13/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D13/A0 and as shown in ILL. 81.

The fire and hose stream tests were conducted on June 11, 1984.

RESULTS

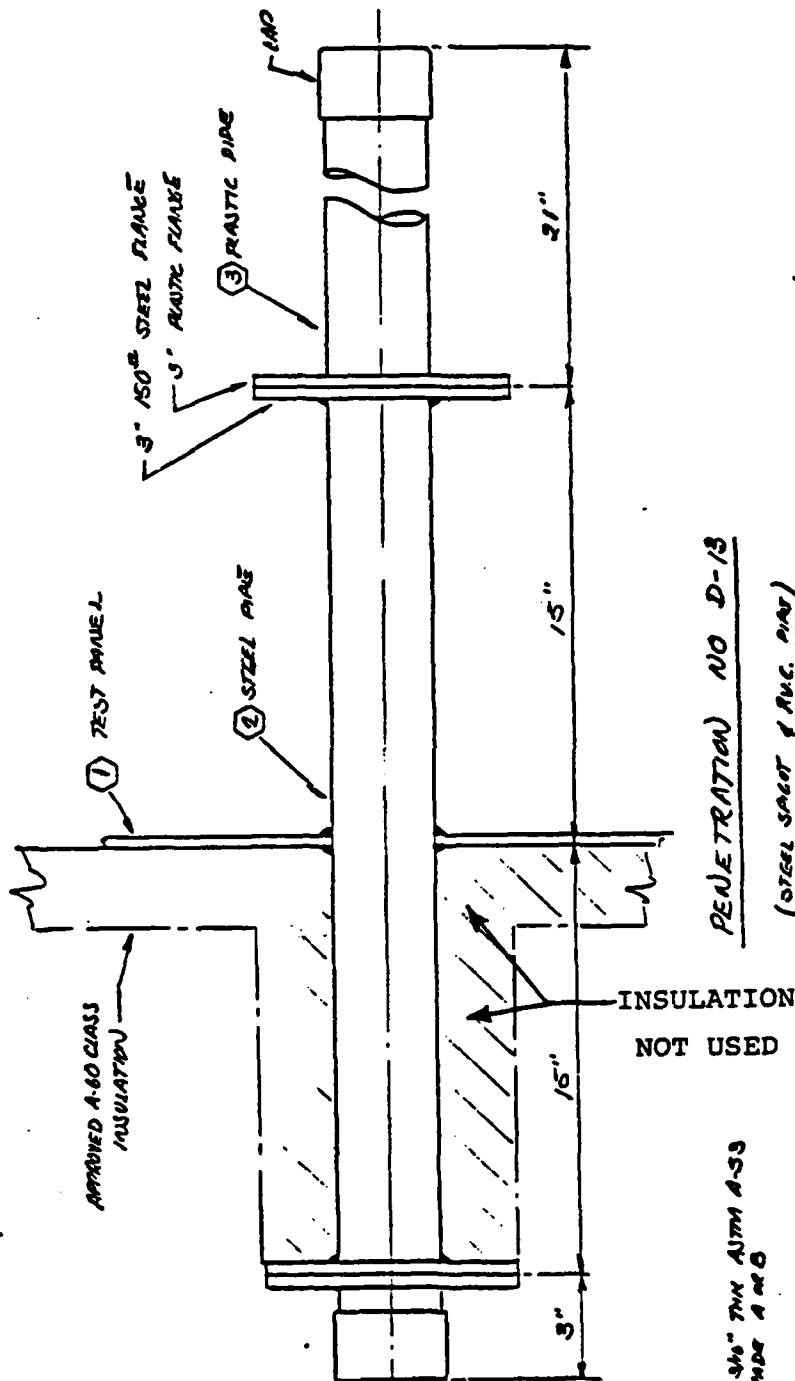
Observations During Fire Test - By 38 min, the unexposed surface of the deck was glowing red.

No significant changes occurred during the remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 82.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 83 through 83B.

Pictorial History - Photographs were obtained during the fire test. Due to a malfunction of the photographic equipment, photographs of the hose stream test were not taken. No projection of water through the assembly was observed during the hose stream test.



ASSEMBLY D-13/A0

JUNE 11, 1984

① STEEL PLATE 3/16" THK ASTM A-36
GRADE A & B

② 3" SCH 40 STEEL PIPE ASTM A-53
GRADE A & B

③ 8" SCH 40 PVC PIPE ASTM D-1784/1805

TITLE:	DECK
DATE:	NOV 84
BY:	YHS
REV:	—
FIG. NO.:	D-13

USNC142

SAMPLE D-13/AO
TEST DATE JUNE 11, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 12 in. above unexposed surface.
4	On penetrant, at interface of flange and plastic pipe.
5	On penetrant, 18 in. above unexposed surface.
6	On penetrant, 24 in. above unexposed surface.
7	On unexposed surface, at interface of penetrant and unexposed surface.
8	On unexposed surface, 6 in. from penetrant.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 12 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 82

US COAST GUARD D13/A0
6-11-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	1	2	3	4
TIME (MIN'S)				
0	71.7	71.3	71.1	71.5
4	187.8	98.8	80.8	73.2
8	408.5	202.6	116.9	80.9
12	625.5	364.9	178.2	93.7
16	755.1	486.4	244.9	106.9
20	812.7	560.6	301.1	119.2
24	852.3	609.6	346.5	128.5
28	881.3	643.4	384.1	137.0
32	899.7	666.6	414.3	149.5
36	915.7	687.5	443.2	163.2
40	929.1	699.3	465.9	175.1
44	941.3	711.1	483.6	185.9
48	954.7	722.0	500.3	195.9
52	966.1	731.0	513.8	204.2
56	978.1	745.7	531.3	211.4
60	991.9	755.9	545.9	218.3

US COAST GUARD D13/A0
6-11-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	71.6	71.6	71.0	72.3
4	73.8	74.4	297.4	456.9
8	83.7	85.2	654.6	921.3
12	98.6	103.5	884.9	1077.5
16	112.9	121.4	984.7	1111.3
20	125.3	136.4	1034.1	1132.6
24	134.3	149.8	1072.6	1131.7
28	144.7	161.6	1099.5	1140.0
32	156.9	173.4	1120.5	1159.2
36	170.4	184.0	1136.0	1173.7
40	182.9	196.5	1149.2	1184.0
44	192.7	206.3	1164.1	1203.8
48	201.4	215.4	1181.9	1228.4
52	207.3	222.9	1196.3	1250.5
56	213.3	229.2	1211.4	1274.9
60	219.4	235.5	1227.1	1290.4

US COAST GUARD D13/A0
6-11-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

9

10

11

TIME
(MIN'S)

0	72.4	72.4	72.5
4	417.0	414.4	349.1
8	886.6	822.7	754.4
12	1050.3	981.7	941.4
16	1095.0	1057.0	1018.9
20	1122.6	1104.7	1065.4
24	1151.7	1126.3	1110.2
28	1165.5	1146.6	1143.5
32	1178.7	1169.6	1160.9
36	1185.9	1185.6	1181.9
40	1191.6	1193.8	1197.5
44	1208.9	1212.8	1216.4
48	1231.5	1233.7	1233.5
52	1252.0	1251.2	1246.5
56	1272.3	1271.5	1262.1
60	1289.4	1284.8	1275.3

T E S T R E C O R D D13/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D13/A60 and as shown in ILL. 84.

The fire and hose stream tests were conducted on June 22, 1984.

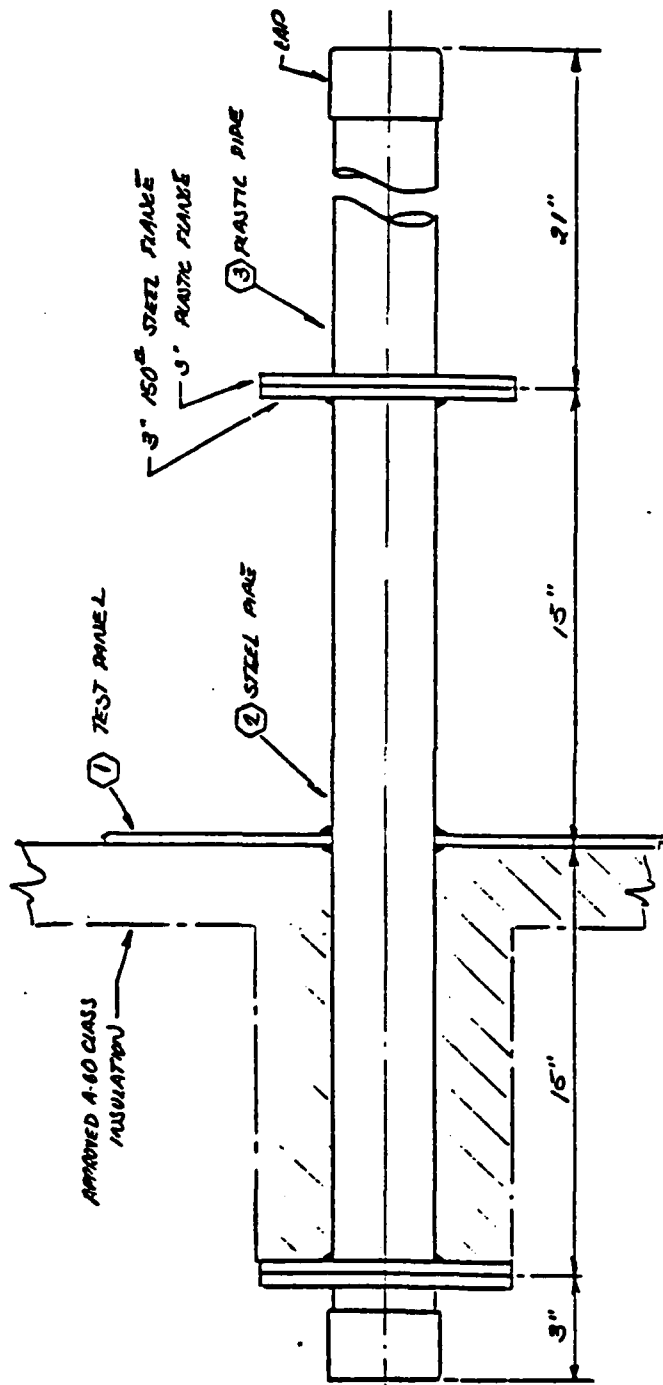
RESULTS

Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 85.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 86 through 86B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-13/A60

JUNE 22, 1984

PENETRATION NO D-13

(STEEL SHOOT & PVC. PIPE)

① STEEL PLATE 3/16" THK ASTM A53
GRADE A OR B

② 8" SCH 40 STEEL PIPE ASTM A53
GRADE A OR B

③ 8" SCH 40 PVC PIPE ASTM D-1784/1805

TITLE:	DECK
DATE:	NOV 84
BY:	YNO
SCALE:	1" = 1'-0"
REV:	
FIG. NO.:	D-13

USNC142

ILL. 84

SAMPLE D-13/A60
TEST DATE JUNE 22, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 12 in. above unexposed surface.
4	On penetrant, at interface of flange and plastic pipe.
5	On penetrant, 18 in. above unexposed surface.
6	On penetrant, 24 in. above unexposed surface.
7	On unexposed surface, at interface of penetrant and unexposed surface.
8	On unexposed surface, 6 in. from penetrant.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 12 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 85

US COAST GUARD D13/A60
6-22-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	72.2	72.2	72.1	72.3
4	72.6	72.5	72.4	72.5
8	74.4	73.9	73.2	72.8
12	76.4	75.1	73.7	73.2
16	80.2	78.2	74.3	73.7
20	87.2	82.6	77.1	74.3
24	95.9	88.8	79.7	75.3
28	108.1	96.8	83.4	76.6
32	121.0	107.7	88.2	78.4
36	132.3	117.1	93.1	80.5
40	141.9	124.7	98.6	83.3
44	153.4	131.3	103.6	86.4
48	168.5	137.0	108.3	89.9
52	187.9	142.2	111.7	92.0
56	209.5	148.4	115.6	94.9
60	230.4	156.8	119.7	98.5

US COAST GUARD D13/A60
6-22-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	72.6	72.7	72.7	73.5
4	72.9	73.1	72.9	73.5
8	73.4	73.6	74.4	75.5
12	73.9	74.3	76.5	79.2
16	74.5	75.1	80.6	85.4
20	75.1	75.9	87.6	95.4
24	75.0	76.9	96.2	111.2
28	78.7	77.9	108.5	128.6
32	81.9	80.3	121.7	144.1
36	84.9	82.6	134.5	158.4
40	88.0	85.6	147.2	175.2
44	92.0	88.8	162.9	190.9
48	95.4	91.8	184.5	206.4
52	98.2	93.1	208.2	221.7
56	100.8	95.5	231.1	235.9
60	103.5	98.0	251.9	250.1

US COAST GUARD D13/A60
6-22-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11
TIME			
(MIN'S)			
0	72.5	72.5	72.8
4	73.1	72.0	73.3
8	75.3	76.2	75.9
12	78.9	80.8	79.7
16	84.5	88.4	86.4
20	93.3	100.5	95.7
24	104.4	118.5	109.1
28	118.3	137.2	123.4
32	132.6	152.3	138.1
36	145.5	167.8	150.1
40	160.0	182.6	164.6
44	174.4	196.2	178.1
48	188.3	209.2	189.2
52	203.4	221.8	200.6
56	216.8	233.6	212.0
60	229.2	245.1	220.8

T E S T R E C O R D D14/A0

SAMPLE:

The fire test was conducted on the assembly identified as D14/A0 and as shown in ILL. 87.

The fire test was conducted on June 11, 1984.

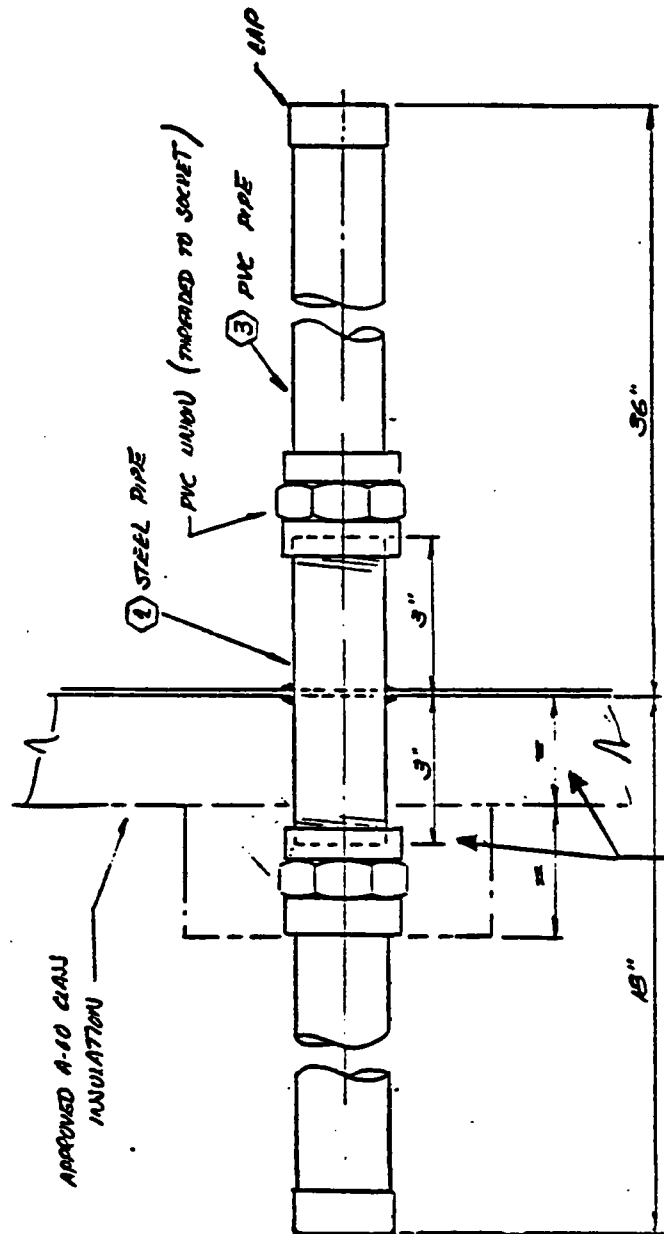
RESULTS

Observations During Fire Test - By 15 min, light amounts of smoke were issuing from the penetrant. By 25 min, the penetrant was beginning to sag and continued to issue heavy amounts of smoke. By 28 min, the penetrant had ignited. The flames were extinguished and the fire test was allowed to continue. By 34 min, the unexposed surface of the deck was glowing red. By 42 min, the penetrant re-ignited. By 44 min, the penetrant had collapsed and the fire test was terminated.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 88.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 89 through 89B.

Pictorial History - Photographs were obtained during the fire test. Because the penetrant collapsed during the fire test, the hose stream test was not conducted.



ASSEMBLY D-14/A0
JUNE 11, 1984

PENETRATION NO D-14
(STEEL SPOOT & PVC PIPE)

INSULATION
NOT USED

- (1) STEEL PIPE 3/4" THK ASTM A-53
GRADE A OR B
- (2) 3" SCH 40 SEAMLESS STEEL PIPE
ASTM A-53 GRADE A OR B
- (3) 3" SCH 40 PVC PIPE ASTM D-1784/1805

TITLE:	DECK	NOTE:	FIG 84
	PENETRATION	DESIGNED BY:	7103
		SCALE:	-
		DATE:	REV

USNC142

SAMPLE D-14/AO
TEST DATE JUNE 11, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, at interface of steel pipe and union.
3	On the surface of penetrant's PVC union.
4	On penetrant, at interface of PVC union and PVC pipe.
5	On penetrant, 12 in. above unexposed surface.
6	On penetrant, 18 in. above unexposed surface.
7	On penetrant, 24 in. above unexposed surface.
8	On unexposed surface, at interface of penetrant and unexposed surface.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 6 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.
12	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 88

US COAST GUARD D14/A0
6-11-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	89.0	86.2	75.6	75.0
4	240.2	200.3	87.6	81.1
8	554.1	441.5	127.4	106.7
12	859.3	769.4	196.8	146.1
16	999.7	955.3	266.9	193.3
20	1078.5	1030.6	309.2	226.5
24	1128.7	1081.5	355.0	249.1
28	1185.1	1210.6	406.6	271.6
32	1017.1	1173.6	406.2	180.8
36	1184.7	1293.7	465.6	187.9
40	1261.8	1352.4	603.2	209.2
44	1285.3	1348.2	669.3	280.4

US COAST GUARD D14/A0
6-11-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

5

6

7

8

TIME
(MIN'S)

0	76.5	76.1	76.1	93.1
4	83.5	81.1	78.9	310.4
8	115.3	102.2	91.3	711.3
12	164.2	141.9	114.8	1003.0
16	218.4	176.7	142.6	1131.8
20	260.4	203.1	161.7	1185.7
24	291.5	223.8	175.6	1218.5
28	316.5	244.3	192.4	1260.5
32	304.1	263.8	209.9	775.9
36	338.5	276.9	222.1	788.6
40	363.4	291.1	233.0	1260.4
44	390.1	304.9	245.1	1294.7

US COAST GUARD D14/A0
6-11-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
0	99.2	96.6	102.1	93.8
4	483.6	481.2	427.0	392.7
8	899.3	924.8	809.5	607.9
12	1044.7	1084.7	965.1	792.2
16	1103.9	1135.4	1044.8	848.4
20	1130.2	1157.7	1108.1	948.2
24	1170.1	1190.1	1135.8	938.3
28	1188.7	1219.0	1151.9	983.5
32	524.4	1124.5	1145.8	991.6
36	620.7	1092.3	981.1	999.7
40	1148.2	1269.7	1159.7	988.2
44	1184.6	1293.8	1168.2	1086.7

T E S T R E C O R D D14/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D14/A60 and as shown in ILL. 90.

The fire and hose stream tests were conducted on July 2, 1984.

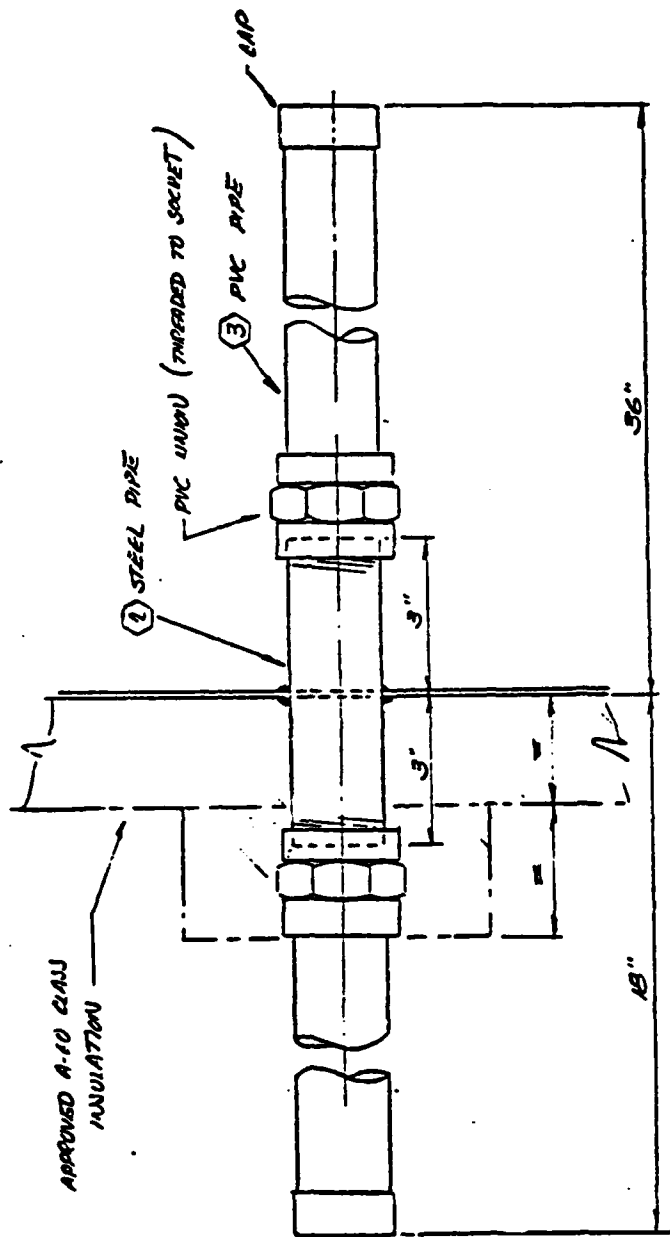
RESULTS

Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 91.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 92 through 92B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-14/A60
JULY 2, 1984

(1) STEEL PIPE 3/16" THK ASTM A-53
GRADE A OR B

(2) 3" SCH 40 SEAMLESS STEEL PIPE
ASTM A-53 GRADE A OR B

(3) 3" SCH 40 PVC PIPE ASTM D-1784/1785

PENETRATION NO D-14
(STEEL JOINT & PVC PIPE)

DATE:	DEC 84
DESIGNED BY:	WJS
SCALE:	1" = 1'
REV:	
TITLE:	DECK PENETRATION
PROJECT NO:	D-14

USNC142

ILL. 90

SAMPLE D-14/A60
TEST DATE JULY 2, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, at interface of steel pipe and union.
3	On the surface of penetrant's PVC union.
4	On penetrant, at interface of PVC union and PVC pipe.
5	On penetrant, 12 in. above unexposed surface.
6	On penetrant, 18 in. above unexposed surface.
7	On penetrant, 24 in. above unexposed surface.
8	On unexposed surface, at interface of penetrant and unexposed surface.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 6 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.
12	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 91

US COAST GUARD D14/A60
7-2-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	1	2	3	4
TIME (MIN'S)				
0	74.7	74.0	75.1	75.6
4	76.9	75.7	75.8	76.5
8	83.4	77.9	76.4	79.0
12	84.7	80.3	77.3	81.4
16	88.4	82.1	78.2	83.3
20	93.9	84.5	79.3	85.2
24	100.3	87.0	80.7	88.8
28	110.0	91.0	82.4	92.5
32	122.3	96.0	84.7	96.0
36	135.9	100.9	86.6	100.2
40	156.6	108.4	88.9	108.3
44	175.7	118.9	91.0	115.6
48	193.4	126.8	93.0	121.7
52	204.2	134.5	95.7	124.7
56	209.2	138.2	98.4	123.0
60	216.0	142.3	102.1	121.2

US COAST GUARD D14/A60
7-2-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	75.9	76.1	76.1	74.0
4	76.6	76.3	76.8	76.1
8	79.3	78.3	77.7	80.6
12	80.5	79.5	78.8	82.9
16	82.2	80.6	79.8	86.2
20	82.0	81.5	80.6	91.4
24	84.0	82.7	81.8	97.5
28	89.9	84.1	83.2	106.9
32	93.9	85.0	84.6	118.2
36	97.8	88.6	85.8	130.8
40	105.0	94.4	87.1	147.5
44	112.5	101.1	89.5	164.8
48	117.6	105.2	93.3	183.4
52	119.9	107.7	95.7	197.0
56	118.9	107.9	95.7	207.7
60	117.8	106.9	96.5	214.6

US COAST GUARD D14/A60
7-2-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

9

10

11

12

TIME
(MIN'S)

0	75.1	75.1	75.1	75.2
4	75.9	75.0	75.0	76.8
8	78.5	78.7	78.6	79.0
12	82.6	82.9	82.4	84.4
16	89.2	89.7	88.7	91.8
20	98.7	99.2	98.1	101.7
24	113.1	113.5	112.1	115.7
28	128.3	128.9	126.9	130.3
32	142.2	143.7	140.2	143.8
36	156.4	159.8	154.4	158.2
40	173.7	178.4	169.9	173.3
44	189.9	196.0	184.5	187.8
48	204.3	211.7	197.5	201.1
52	217.6	226.2	209.1	213.1
56	228.9	232.6	219.9	222.9
60	238.2	239.6	229.7	230.4

T E S T R E C O R D D15/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D15/A0 and as shown in ILL. 93.

The fire and hose stream tests were conducted on June 5, 1984.

RESULTS

Observations During Fire Test - By 40 min, the unexposed surface of the deck was glowing red.

No significant changes occurred during the remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 94.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 95 through 95B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.

SAMPLE D-15/AO
TEST DATE JUNE 5, 1984

<u>T.C.</u>	<u>Location</u>
1	Interface of penetrant and unexposed surface.
2	On penetrant, 1 in. above unexposed surface.
3	On penetrant, 6 in. above unexposed surface.
4	On penetrant, 12 in. above unexposed surface.
5	On penetrant, 16 in. above unexposed surface.
6	On penetrant, 18 in. above unexposed surface.
7	On penetrant, 24 in. above unexposed surface.
8	On unexposed surface, 12 in. from penetrant.
9	On unexposed surface, 12 in. from penetrant.
10	On unexposed surface, 1 in. from penetrant.
11	On unexposed surface, 1 in. from penetrant.
12	At interface of steel pipe and PVC pipe, 15 in. above unexposed surface.

USNC142
ILL. 94

US COAST GUARD D15/A0
6-5-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	1	2	3	4
TIME				
(MIN'S)				
0	97.4	90.8	86.0	86.7
4	275.2	193.7	101.4	91.9
8	548.6	377.7	164.6	111.2
12	777.5	554.2	259.7	155.5
16	907.3	685.8	347.1	204.4
20	974.4	760.7	414.4	249.6
24	1029.4	838.5	471.0	289.8
28	1073.5	890.5	524.1	324.2
32	1109.3	926.9	571.7	355.0
36	1135.5	949.2	586.1	379.3
40	1159.5	969.3	600.1	400.2
44	1182.1	987.3	612.3	417.2
48	1201.3	1002.8	623.1	431.1
52	1217.3	1016.2	633.5	444.8
56	1230.7	1024.4	642.3	456.8
60	1238.2	1035.8	642.4	463.2

US COAST GUARD D15/A0
6-5-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	87.3	87.5	87.6	102.3
4	90.9	91.8	90.5	398.1
8	103.0	106.1	99.8	774.3
12	123.3	129.6	117.5	956.5
16	146.0	154.1	136.2	1033.7
20	165.2	174.3	152.6	1077.6
24	183.0	193.6	167.0	1101.9
28	200.5	211.1	180.8	1128.0
32	219.0	227.9	194.5	1160.1
36	233.3	239.5	205.0	1182.5
40	247.4	251.8	214.7	1204.4
44	259.4	261.8	222.3	1221.0
48	270.0	269.1	227.7	1232.3
52	278.7	273.9	230.8	1243.3
56	279.3	271.8	230.3	1251.4
60	213.2	237.6	221.7	1273.1

US COAST GUARD D15/A0
6-5-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
0	99.8	96.9	98.7	86.8
4	370.7	322.9	417.3	89.2
8	726.3	679.7	817.7	98.7
12	948.7	909.6	1015.6	121.7
16	1038.1	1021.2	1089.8	152.9
20	1086.7	1074.2	1111.4	183.3
24	1121.6	1097.4	1157.7	206.9
28	1151.7	1130.5	1192.7	229.1
32	1167.2	1156.5	1220.9	253.2
36	1179.6	1177.7	1244.7	273.0
40	1192.2	1197.4	1269.2	291.9
44	1199.9	1214.8	1285.7	309.8
48	1212.8	1231.4	1305.8	323.4
52	1217.0	1246.5	1319.1	332.8
56	1229.1	1261.1	1334.7	314.6
60	1230.2	1268.0	1331.9	271.3

T E S T R E C O R D D15/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D15/A60 and as shown in ILL. 96.

The fire and hose stream tests were conducted on June 19, 1984.

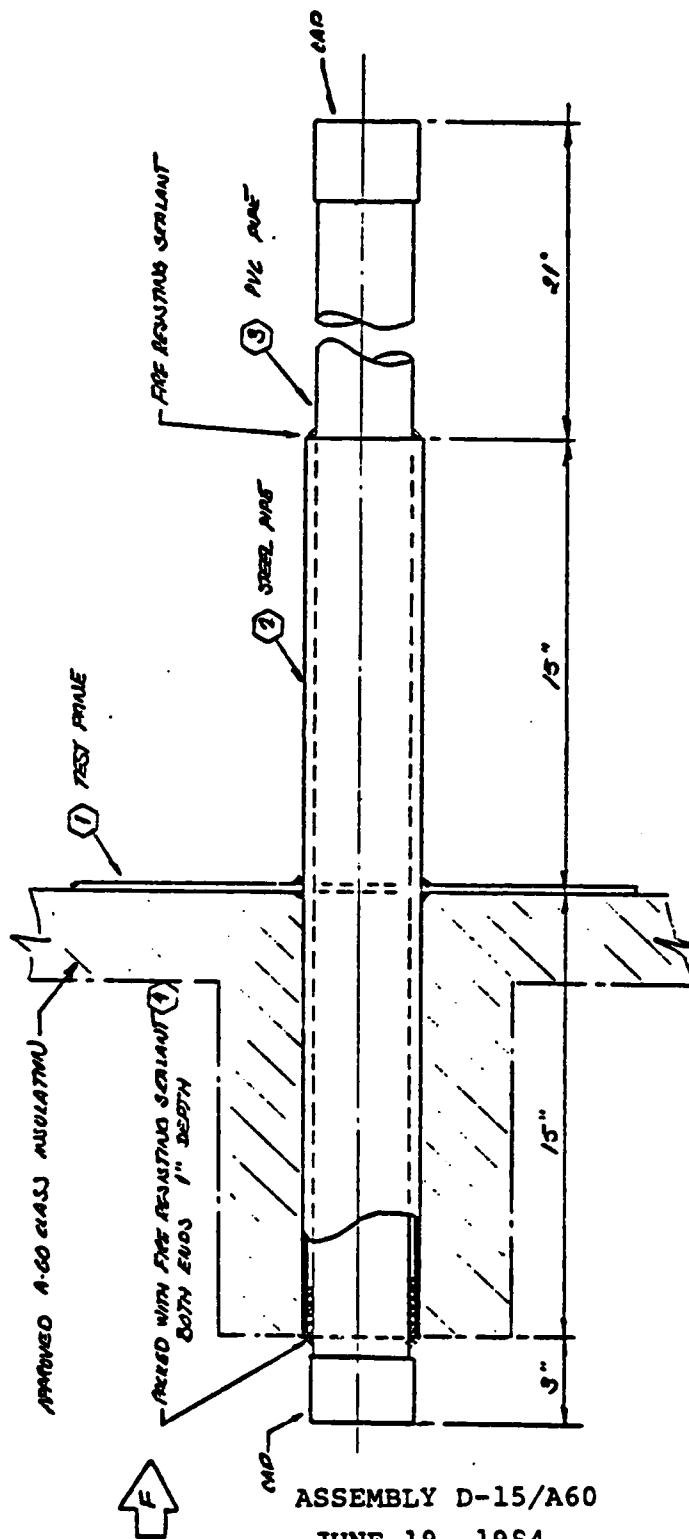
RESULTS

Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 97.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 98 through 98B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-15/A60
JUNE 19, 1964

PENETRATION NO D-15
(STEEL SHEET & FIRE SEALANT)

- ① STEEL PLATE 1/2" THK ASTM A-53
GRADE A & B
- ② 4" GEN-40 SEMI-STRUCTURAL STEEL FIRE
ASTM A-53 GRADE A & B
- ③ 3" GEN-40 MC. FIRE ASTM D-180/1905
- ④ FIRE SEALANT

DATE: 12/8/84	REV: 1
DESIGN: 7/8	REV: 1
SHEET: 1	REV: 1
FILE: DECK	REV: 1
PENETRATION	REV: 1
DESIGN: D-15	REV: 1

USNC142

SAMPLE D-15/A60
TEST DATE JUNE 19, 1984

<u>T.C.</u>	<u>Location</u>
1	Interface of penetrant and unexposed surface.
2	On penetrant, 1 in. above unexposed surface.
3	On penetrant, 6 in. above unexposed surface.
4	On penetrant, 12 in. above unexposed surface.
5	On penetrant, 16 in. above unexposed surface.
6	On penetrant, 18 in. above unexposed surface.
7	On penetrant, 24 in. above unexposed surface.
8	On unexposed surface, 12 in. from penetrant.
9	On unexposed surface, 12 in. from penetrant.
10	On unexposed surface, 1 in. from penetrant.
11	On unexposed surface, 1 in. from penetrant.
12	At interface of steel pipe and PVC pipe, 15 in. above unexposed surface.

USNC142
ILL. 97

US COAST GUARD D15/A60
6-19-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

TIME
(MIN'S)

	1	2	3	4
0	78.8	78.8	78.9	79.1
4	79.2	79.1	79.2	79.5
8	79.8	79.6	79.6	79.9
12	81.9	81.6	80.0	80.7
16	85.7	84.9	83.2	82.2
20	91.1	89.5	86.1	84.2
24	97.0	94.0	89.2	85.0
28	106.4	101.1	92.7	87.0
32	117.9	110.3	95.9	90.1
36	130.8	120.9	100.5	92.2
40	144.3	132.4	106.3	93.6
44	159.3	145.2	113.1	96.6
48	176.6	159.7	119.9	99.2
52	193.6	174.0	126.9	102.2
56	210.7	189.1	135.1	105.9
60	226.7	203.8	142.4	108.9

US COAST GUARD D15/A60
6-19-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

5

6

7

8

TIME
(MIN'S)

0	79.6	79.8	79.0	79.2
4	79.0	80.3	80.4	79.9
8	80.0	81.2	80.9	82.3
12	83.7	83.3	81.0	86.1
16	86.9	85.9	83.4	91.9
20	89.5	88.4	85.2	100.9
24	91.1	89.8	86.3	114.9
28	92.1	90.0	87.3	130.6
32	93.2	92.1	88.5	145.9
36	93.9	92.9	89.6	160.1
40	94.1	93.5	90.0	177.4
44	96.3	95.8	91.0	193.6
48	97.7	97.4	92.4	208.3
52	98.9	98.3	93.2	222.2
56	100.6	99.8	94.2	235.3
60	101.8	100.5	95.1	246.6

US COAST GUARD D15/A60
6-19-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
0	79.2	83.7	79.4	79.3
4	79.9	89.0	80.1	79.7
8	81.8	97.0	82.1	80.6
12	84.9	105.6	85.2	82.0
16	89.7	122.2	89.6	85.6
20	96.5	123.7	95.6	87.7
24	107.8	134.7	105.8	89.5
28	121.4	138.1	118.1	91.3
32	135.6	144.4	130.6	92.6
36	148.3	148.0	143.0	93.0
40	164.6	143.2	156.9	94.3
44	179.9	151.5	172.2	96.3
48	194.5	152.0	186.1	98.2
52	208.1	157.9	197.2	100.6
56	221.3	160.8	209.1	102.3
60	232.4	166.7	221.4	104.9

T E S T R E C O R D D16/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D16/A0 and as shown in ILL. 99.

The fire and hose stream tests were conducted on June 4, 1984.

RESULTS

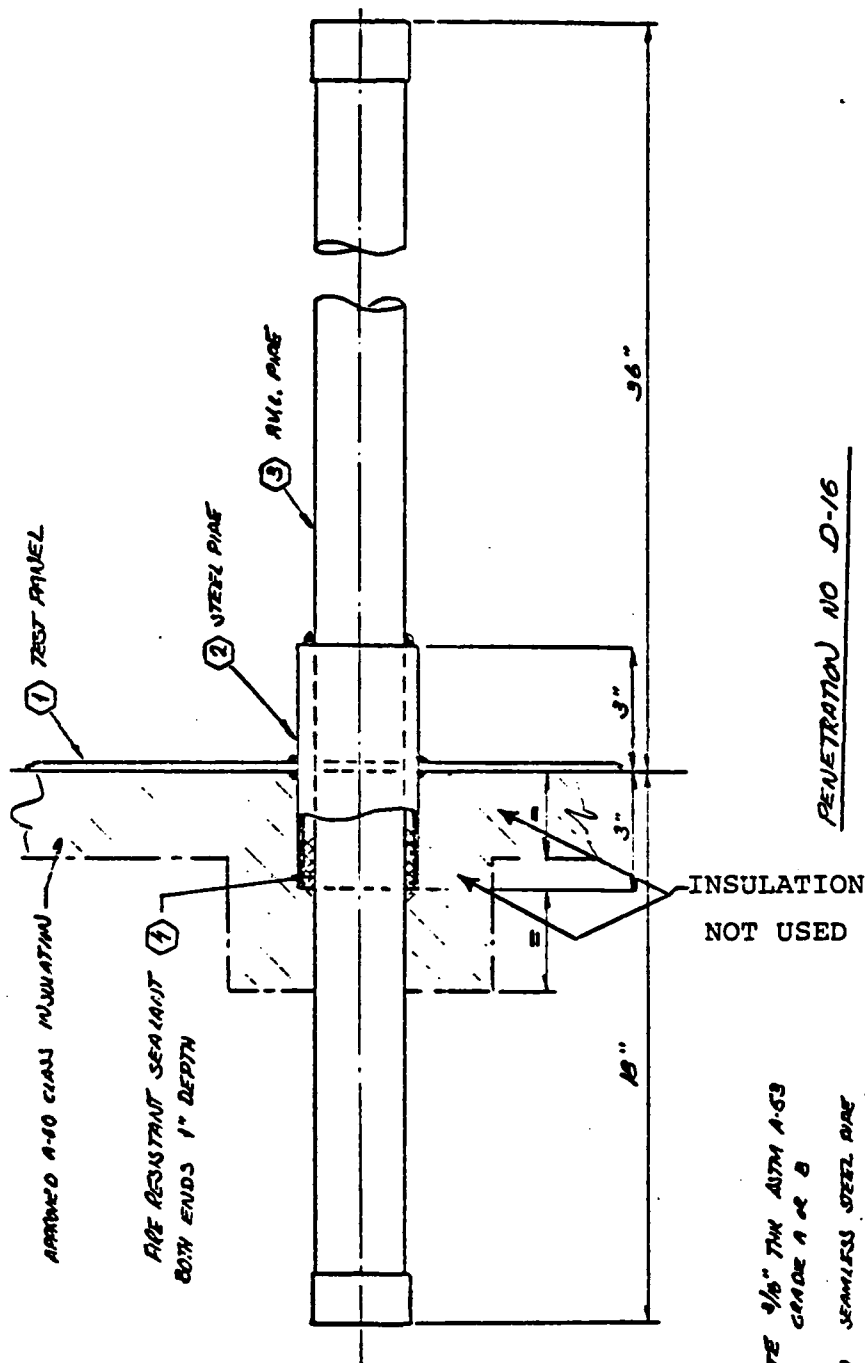
Observations During Fire Test - By 40 min, the unexposed surface of the deck was glowing red.

No significant changes occurred during the remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 100.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 101 through 101B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-16/A0

JUNE 4, 1984

- (1) STEEL PLATE 1/4" THK ASTM A-53
GRADE A OR B
- (2) 4" SCH 40 SEAMLESS STEEL PIPE
ASTM A-53 GRADE A OR B
- (3) 3" SCH 40 AVG. PLATE ASTM D-1084/1085
- (4) FIRE SEALANT

PENETRATION NO D-16

(STEEL SEALANT & AVG. PLATE)

INSULATION
NOT USED

DATE:	REV. BY:	REV. NO.:
	7/8	
TITLE:		
DECK		
PENETRATION		
DRAWN BY:		DATE:
D-16		D-16

USNC142

ILL. 99

SAMPLE D-16/AO
TEST DATE JUNE 4, 1984

<u>T.C.</u>	<u>Location</u>
1	Interface of penetrant and unexposed surface.
2	On surface of steel pipe, 1 in. above unexposed surface.
3	On surface of PVC pipe, 4 in. above unexposed surface.
4	On surface of PVC pipe, 6 in. above unexposed surface.
5	On surface of PVC pipe, 12 in. above unexposed surface.
6	On surface of PVC pipe, 18 in. above unexposed surface.
7	On surface of PVC pipe, 24 in. above unexposed surface.
8	On unexposed surface, 12 in. from penetrant.
9	On unexposed surface, 12 in. from penetrant.
10	On unexposed surface, 1 in. from penetrant.
11	On unexposed surface, 1 in. from penetrant.

USNC142
ILL. 100

US COAST GUARD B16/A0
6-4-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	95.4	93.0	89.5	89.5
4	288.9	214.2	105.4	97.4
8	638.0	432.7	168.5	137.2
12	851.4	620.2	251.4	196.4
16	962.2	756.2	306.5	240.5
20	1024.9	844.5	351.4	285.2
24	1071.6	909.3	340.2	323.1
28	1096.5	948.5	399.1	349.4
32	1114.2	969.5	425.5	367.9
36	1137.1	987.5	457.4	379.6
40	1157.3	1006.2	489.0	406.0
44	1164.1	1020.0	511.2	428.3
48	1174.1	1031.3	526.8	444.8
52	1191.3	1047.0	566.2	466.6
56	1213.3	1062.9	594.6	485.3
60	1220.3	1072.6	632.6	502.3

US COAST GUARD D16/A0
6-4-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	89.4	89.4	89.5	101.6
4	92.7	91.8	90.0	379.8
8	114.4	102.2	97.2	767.3
12	153.6	125.7	111.9	928.3
16	181.1	144.4	126.5	1004.2
20	212.3	161.5	140.4	1064.4
24	238.0	180.7	151.9	1100.1
28	262.8	197.1	162.0	1137.8
32	285.9	212.3	173.0	1163.3
36	304.4	224.9	182.9	1184.3
40	319.8	234.5	189.1	1201.4
44	332.7	243.0	195.4	1214.6
48	341.4	250.4	201.6	1229.8
52	352.4	260.9	210.3	1243.4
56	356.1	266.7	215.2	1265.6
60	357.7	269.9	218.4	1260.8

US COAST GUARD D16/A0
6-4-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

9

10

11

TIME
(MIN'S)

0	101.8	98.4	
4	358.8	355.6	424.0
8	713.3	724.9	826.6
12	896.1	915.8	1006.6
16	977.7	1009.2	1073.7
20	1030.4	1063.9	1108.5
24	1070.3	1097.1	1134.0
28	1107.2	1115.4	1157.4
32	1139.3	1126.3	1175.4
36	1166.7	1137.0	1193.7
40	1184.6	1151.6	1215.2
44	1178.2	1156.9	1223.0
48	1188.3	1170.5	1237.9
52	1191.6	1186.8	1254.4
56	1213.1	1206.5	1272.4
60	1203.3	1210.9	1273.0

T E S T R E C O R D D16/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D16/A60 and as shown in ILL. 102.

The fire and hose stream tests were conducted on July 2, 1984.

RESULTS

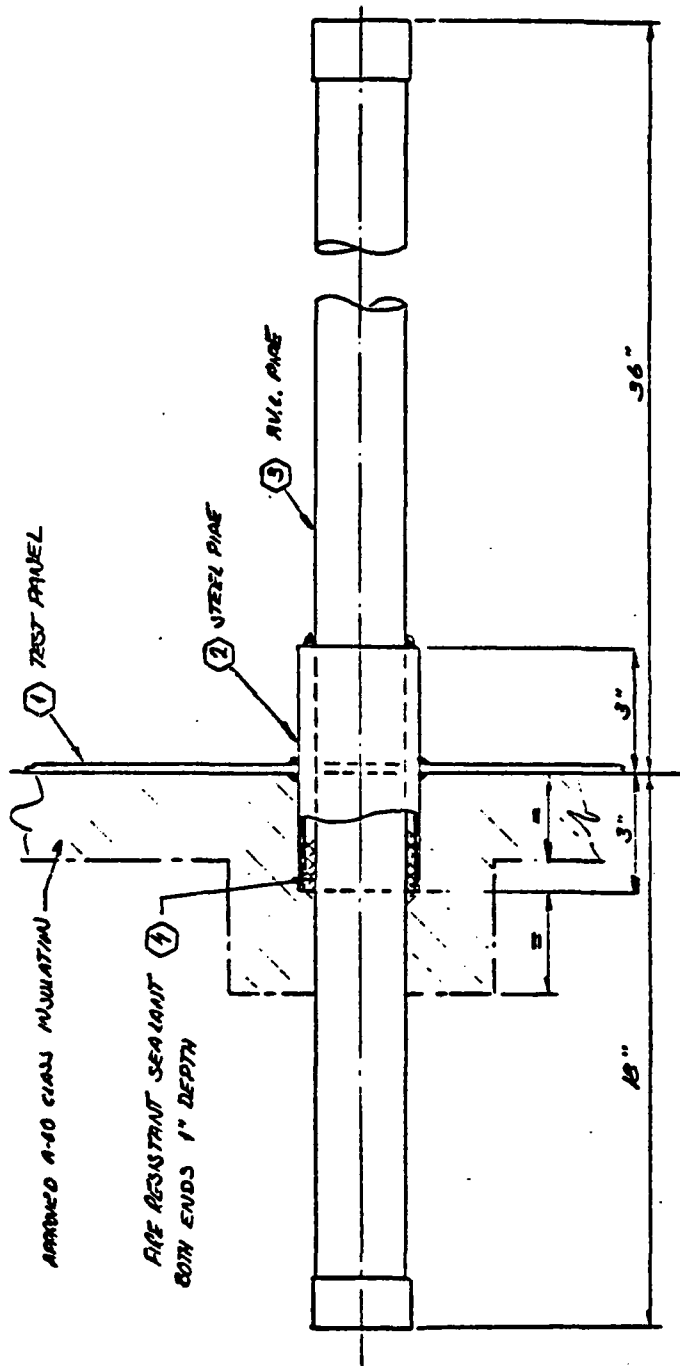
Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 103.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 104 through 104B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.

Thermocouple Failure - The failure of thermocouple #10 did not affect the test results. Thermocouple #10 was located at a position similar to thermocouple #11 and thermocouple #11 was well within the pass limits for Class A-60 fire rating.



ASSEMBLY D-16/A60

JULY 2, 1984

- (1) STEEL PLATE 1/4" THK ASTM A-53 GRADE A OR B
- (2) 4" SCH 40 SEAMLESS STEEL PIPE ASTM A-53 GRADE A OR B
- (3) 8" SCH 40 PVC PIPE ASTM D-1784/1785
- (4) FIRE SEALANT

PENETRATION NO D-16

(STEEL SPACER & PVC PIPE)

TITLE:	DATE:
	REV. BY:
	DATE:
	REV.
DECK	7/8
PENETRATION	
FIG. NO. D-16	

USNC142

ILL. 102

SAMPLE D-16/A60
TEST DATE JULY 2, 1984

<u>T.C.</u>	<u>Location</u>
1	Interface of penetrant and unexposed surface.
2	On surface of steel pipe, 1 in. above unexposed surface.
3	On surface of PVC pipe, 4 in. above unexposed surface.
4	On surface of PVC pipe, 6 in. above unexposed surface.
5	On surface of PVC pipe, 12 in. above unexposed surface.
6	On surface of PVC pipe, 18 in. above unexposed surface.
7	On surface of PVC pipe, 24 in. above unexposed surface.
8	On unexposed surface, 12 in. from penetrant.
9	On unexposed surface, 12 in. from penetrant.
10	On unexposed surface, 1 in. from penetrant.
11	On unexposed surface, 1 in. from penetrant.

USNC142
ILL. 103

US COAST GUARD D16/A60
7-2-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	82.9	82.9	81.1	80.3
4	83.4	83.2	82.5	80.0
8	85.0	84.9	87.6	83.9
12	89.1	88.1	89.5	85.1
16	95.0	93.1	92.1	86.9
20	107.5	104.1	94.8	89.3
24	124.4	119.8	98.3	91.7
28	146.1	139.9	102.7	93.7
32	172.1	164.3	106.9	96.7
36	201.8	192.5	113.8	101.1
40	234.9	223.4	126.2	109.1
44	268.1	254.7	143.1	117.5
48	300.0	286.1	158.1	123.1
52	328.9	315.1	168.6	127.6
56	354.0	341.0	176.0	131.4
60	374.9	362.9	183.3	135.0

USNC142
ILL. 104

US COAST GUARD D16/A60
7-2-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

5

6

7

8

TIME
(MIN'S)

0	82.7	73.7	82.7	82.9
4	83.1	73.6	82.0	84.6
8	84.5	74.6	83.8	87.9
12	85.2	75.1	84.4	91.6
16	86.3	76.1	85.3	96.9
20	87.0	76.9	86.1	107.4
24	89.9	76.9	86.9	121.1
28	91.9	77.3	87.8	136.1
32	93.8	77.7	88.5	151.8
36	95.6	78.6	89.3	172.8
40	100.3	81.8	91.5	191.4
44	106.6	85.1	93.1	206.7
48	111.9	87.9	95.7	220.3
52	115.2	89.5	98.0	233.0
56	117.5	90.0	99.8	245.0
60	119.1	92.2	101.9	255.7

US COAST GUARD D16/A60
7-2-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11
TIME			
(MIN'S)			
0	83.6	82.0	83.2
4	84.0	83.6	83.0
8	87.8	85.8	85.8
12	91.5	89.2	89.1
16	96.5	94.2	94.1
20	106.9	105.7	104.6
24	120.6	124.4	119.6
28	135.6	146.3	138.7
32	150.0	170.7	161.0
36	166.1	0.0	185.6
40	181.5	0.0	212.6
44	195.9	0.0	239.1
48	208.9	0.0	263.6
52	221.0	0.0	286.4
56	231.6	0.0	306.6
60	241.4	0.0	324.1

T E S T R E C O R D D17/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D17/A0 and as shown in ILL. 105.

The fire and hose stream tests were conducted on June 12, 1984.

RESULTS

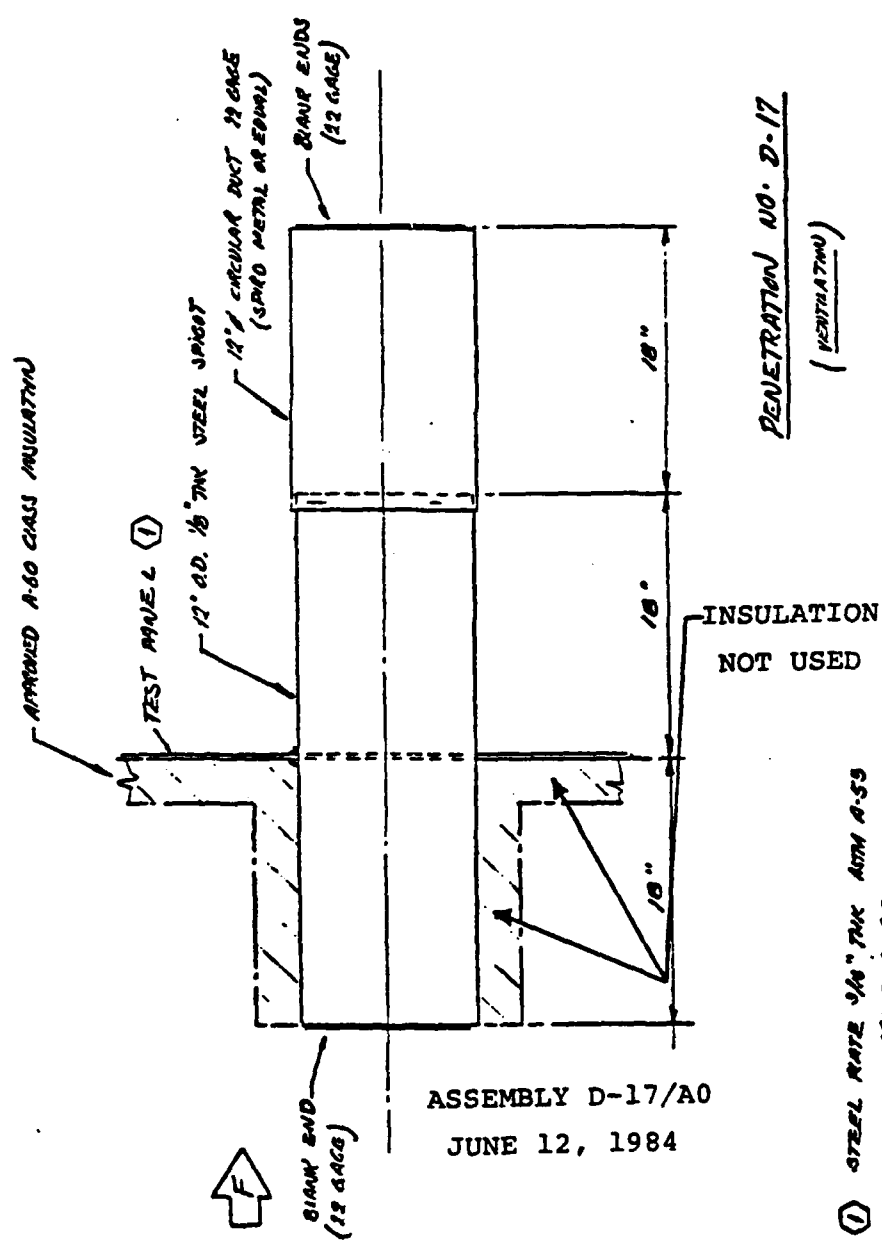
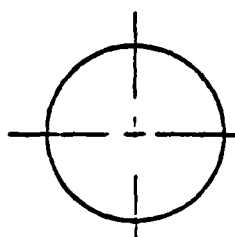
Observations During Fire Test - By 45 min, the unexposed surface of the deck was glowing red.

No significant changes occurred during the remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 106.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 107 through 107B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



DATE:	DATE:
FEB 84	FEB 84
TIME:	TIME:
7/8	7/8
TEST:	TEST:
DECK	DECK
PENETRATION	PENETRATION
DATE:	DATE:
D-17	D-17

① STEEL RITE 3/16" THK WITH A-55 GAGE A & B

SAMPLE D-17/AO
TEST DATE JUNE 12, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 12 in. above unexposed surface.
4	On penetrant, at overlap of steel spigot and duct.
5	On penetrant, 18 in. above unexposed surface.
6	On penetrant, 24 in. above unexposed surface.
7	On unexposed surface, at interface of penetrant and unexposed surface.
8	On unexposed surface, 6 in. from penetrant.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 12 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 106

US COAST GUARD D17/A0
3-12-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	81.6	80.0	80.4	80.5
4	138.5	114.8	100.4	97.7
8	362.5	214.2	164.8	161.7
12	559.8	362.2	267.6	269.3
16	701.3	494.7	379.7	377.6
20	792.6	599.7	481.1	472.4
24	872.7	673.3	557.1	546.3
28	939.6	733.6	614.6	599.9
32	984.8	785.2	647.9	623.9
36	1016.6	838.9	669.9	635.2
40	1041.7	877.2	690.6	644.3
44	1055.8	900.7	705.9	639.3
48	1070.9	915.5	714.3	645.0
52	1083.2	930.1	725.8	654.6
56	1091.4	938.8	733.3	660.9
60	1101.1	947.5	738.9	664.5

US COAST GUARD D17/A0
6-12-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

TIME
(MIN'S)

	5	6	7	8
0	80.6	80.0	82.2	82.8
4	105.8	146.4	283.5	388.9
8	175.7	286.0	549.5	767.9
12	279.0	412.3	758.2	981.3
16	371.5	485.6	892.1	1062.0
20	447.0	529.8	973.0	1116.7
24	505.1	557.6	1028.0	1167.8
28	550.6	581.6	1075.0	1205.8
32	575.2	592.2	1113.6	1238.5
36	591.2	597.6	1145.9	1267.7
40	603.0	604.7	1172.0	1292.0
44	612.6	613.0	1196.4	1316.0
48	615.3	615.0	1213.5	1338.9
52	625.1	623.6	1227.4	1362.2
56	631.0	627.6	1239.0	1381.2
60	635.0	629.5	1249.2	1395.4

AD-A163 315

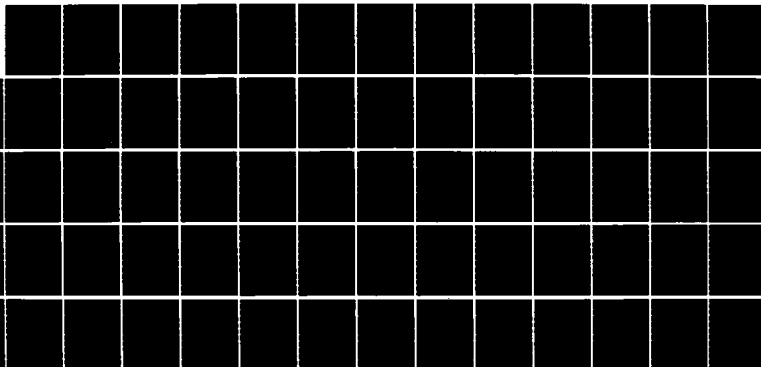
FIRE RESISTANCE TESTING OF BULKHEAD AND DECK
PENETRATIONS(U) COAST GUARD RESEARCH AND DEVELOPMENT
CENTER GROTON CT D E BEENE ET AL. OCT 85 CGR/DC-5/85
USCG-D-33-85

4/4

UNCLASSIFIED

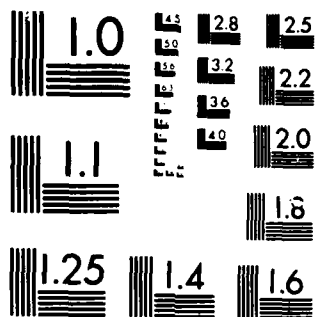
F/G 13/12

NL



END

FORMED
--
GTC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

US COAST GUARD D17/A0
6-12-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

9

10

11

TIME
(MIN'S)

0	82.0	83.3	81.0
4	377.8	304.2	261.2
8	784.5	628.5	546.6
12	971.9	830.4	743.2
16	1062.6	939.0	877.2
20	1133.3	1004.0	956.7
24	1171.8	1057.7	1007.6
28	1203.0	1099.5	1042.8
32	1230.1	1138.1	1073.3
36	1256.9	1169.4	1104.1
40	1281.2	1200.6	1136.5
44	1300.5	1229.4	1167.3
48	1309.2	1255.9	1186.9
52	1310.5	1280.3	1200.1
56	1309.6	1297.4	1210.1
60	1302.8	1312.1	1218.8

T E S T R E C O R D D17/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D17/A60 and as shown in ILL. 108.

The fire and hose stream tests were conducted on July 23, 1984.

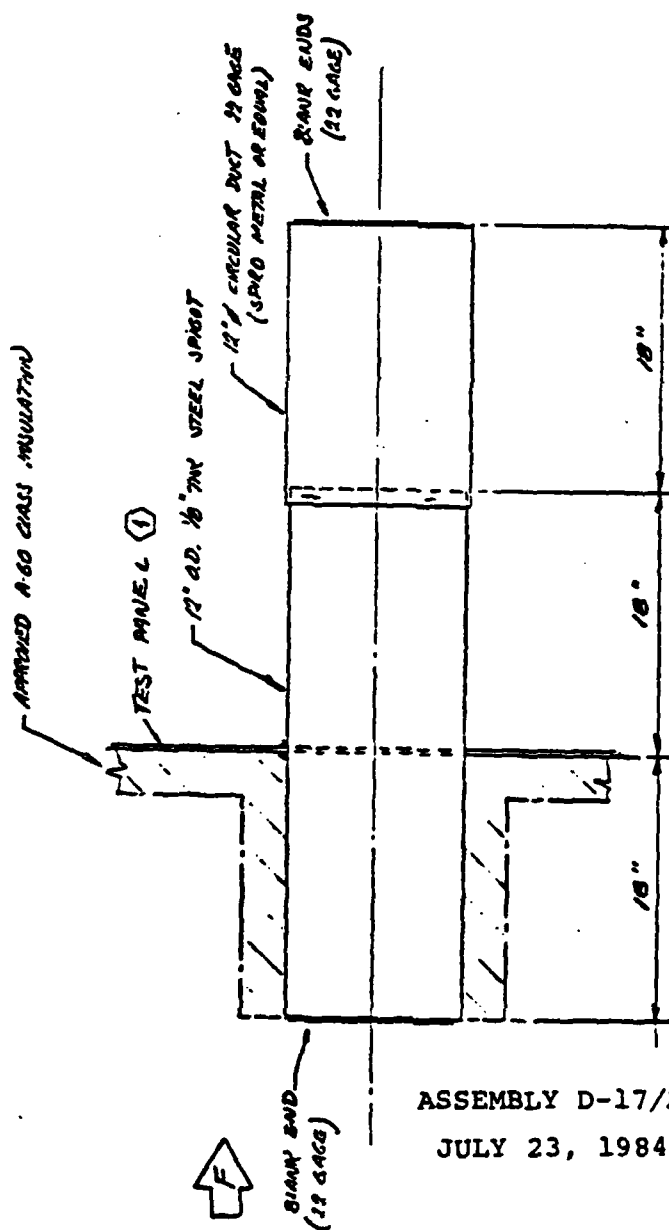
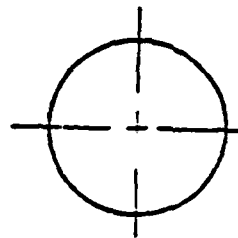
RESULTS

Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 109.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 110 through 110B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-17/A60
JULY 23, 1984

PENETRATION NO. D-17

(VENTILATION)

① STEEL RATE 3/16" THK ASM A-53
GRADE A 60

DATE: 12/08/84	TEST: DECK	SCALE: 1/8"	ITEM: 1
DATE: 12/08/84	TEST: PENETRATION	SCALE: 1/8"	ITEM: 1
DATE: 12/08/84	TEST: D-17	SCALE: 1/8"	ITEM: 1

USNC142

ILL. 108

SAMPLE D-17/A60
TEST DATE JULY 23, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 12 in. above unexposed surface.
4	On penetrant, at overlap of steel spigot and duct.
5	On penetrant, 18 in. above unexposed surface.
6	On penetrant, 24 in. above unexposed surface.
7	On unexposed surface, at interface of penetrant and unexposed surface.
8	On unexposed surface, 6 in. from penetrant.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 12 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 109

US COAST GUARD D17/A60
7-23-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	1	2	3	4
TIME (MIN'S)				
0	85.2	85.2	85.4	85.4
4	93.4	93.2	92.7	91.3
8	114.3	114.6	110.4	106.0
12	140.9	142.2	135.4	128.4
16	171.0	172.8	163.6	153.1
20	200.8	201.6	189.9	175.2
24	236.2	232.5	217.6	198.8
28	274.0	263.2	243.2	217.6
32	317.2	300.6	273.8	242.3
36	355.1	331.8	301.8	263.6
40	387.9	360.9	325.1	282.5
44	422.0	391.9	350.7	301.4
48	453.9	420.0	371.7	316.0
52	481.6	444.2	389.7	330.3
56	509.9	467.8	408.6	343.9
60	532.4	488.7	425.7	357.7

US COAST GUARD D17/A60
7-23-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	85.6	85.6	85.3	85.5
4	94.6	98.9	90.8	85.6
8	116.9	128.9	104.3	87.7
12	142.1	159.3	123.3	92.8
16	166.6	185.2	146.4	98.7
20	187.5	206.7	170.6	109.0
24	210.1	227.6	197.7	123.3
28	227.8	243.6	226.5	140.6
32	252.0	266.5	270.7	159.4
36	271.5	283.2	307.9	184.0
40	288.6	297.9	341.5	207.1
44	305.5	311.6	374.6	227.0
48	318.5	321.7	410.0	243.9
52	330.9	333.1	435.5	257.0
56	343.3	342.4	463.0	270.1
60	355.3	353.0	484.6	281.4

US COAST GUARD D17/A60
7-23-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

9

10

11

TIME
(MIN'S)

0	85.8	85.3	85.8
4	86.3	86.5	86.2
8	89.8	88.9	88.5
12	95.1	92.7	92.2
16	105.2	96.4	96.8
20	121.3	104.2	106.7
24	141.1	115.6	120.0
28	164.5	129.8	134.3
32	188.5	143.9	147.8
36	213.1	157.9	163.3
40	233.3	173.0	176.7
44	250.7	186.7	190.1
48	266.1	199.0	203.1
52	279.6	209.5	215.1
56	292.5	219.8	227.3
60	304.5	228.6	237.2

T E S T R E C O R D D18/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D18/A0 and as shown in ILL. 111.

The fire and hose stream tests were conducted on June 5, 1984.

RESULTS

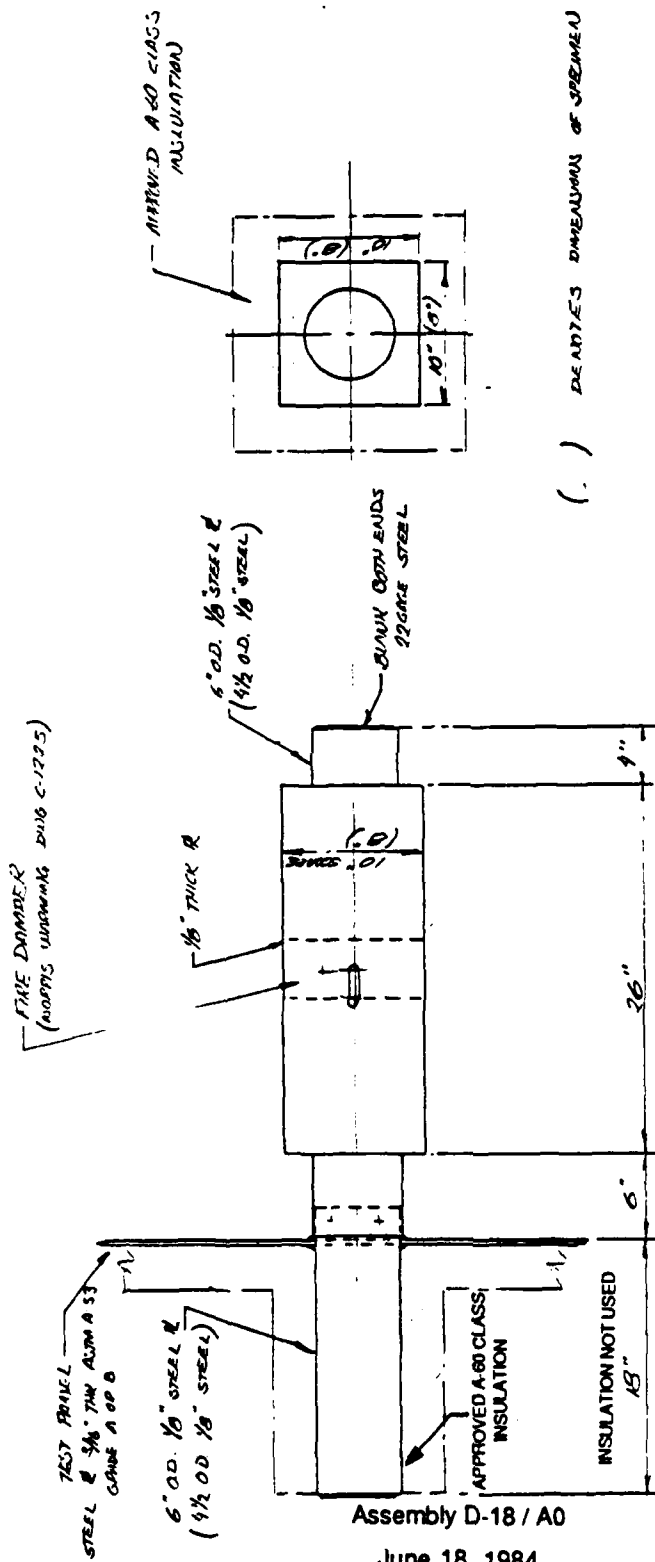
Observations During Fire Test - By 40 min, the unexposed surface of the deck was glowing red.

No significant changes occurred during the remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 112.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 113 through 113B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



(.) DETAILS DIMENSIONS OF SPECIMEN A12

PENETRATION NO D-18
(VENTILATION)

TITLE:	DECK
DATE:	June 84
DESIGNED BY:	
SCALE:	1/8" = 1'-0"
REV:	Δ
DRWG. NO:	D-18

USNC 142

ILL. 111

SAMPLE D-18/AO
TEST DATE JUNE 5, 1984

<u>T.C.</u>	<u>Location</u>
1	Interface of penetrant and unexposed surface.
2	On penetrant, 1 in. above unexposed surface.
3	On penetrant, 6 in. above unexposed surface.
4	On penetrant, 12 in. above unexposed surface.
5	On penetrant, 5 in. below damper.
6	On penetrant, 6 in. above damper.
7	On penetrant, 18 in. above unexposed surface.
8	On penetrant, 24 in. above unexposed surface.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 6 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.
12	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 112

US COAST GUARD D18/A0
6-5-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	107.2	102.7	93.4	92.1
4	326.7	250.4	125.8	95.0
8	663.4	498.9	234.3	112.0
12	936.4	725.2	385.9	147.2
16	1028.1	833.3	534.8	191.8
20	1079.1	884.1	589.9	230.5
24	1126.3	932.0	648.1	266.1
28	1167.1	965.4	695.4	299.2
32	1207.6	996.3	731.4	328.5
36	1243.2	1025.0	767.8	355.7
40	1270.2	1049.1	804.6	383.3
44	1287.5	1066.0	831.4	406.9
48	1302.5	1075.1	839.6	423.5
52	1321.4	1093.9	858.6	440.8
56	1340.2	1105.5	873.8	454.8
60	1355.2	1118.3	892.5	470.9

US COAST GUARD D18/A0
6-5-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	92.5	92.4	91.0	92.1
4	104.2	98.4	92.7	93.3
8	147.0	125.2	99.8	96.6
12	219.8	174.6	115.5	106.4
16	293.1	230.9	137.4	120.3
20	346.8	273.7	157.0	132.3
24	395.9	313.7	177.5	146.2
28	440.7	349.3	198.8	161.3
32	477.9	379.8	217.8	175.8
36	513.6	410.5	236.3	190.0
40	550.3	441.7	256.1	205.8
44	571.0	466.6	272.9	219.4
48	584.6	482.0	285.4	229.7
52	605.4	500.4	299.3	241.6
56	623.5	517.3	311.6	251.9
60	642.2	531.2	322.9	261.2

US COAST GUARD DIS/AO
6-5-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
0	116.8	114.9	107.9	109.0
4	356.1	410.1	333.3	399.5
8	680.4	797.1	691.5	865.7
12	874.9	978.2	926.9	1082.5
16	984.9	1063.6	1040.4	1160.4
20	1040.8	1111.3	1097.1	1207.2
24	1093.3	1158.2	1151.2	1256.6
28	1140.1	1200.6	1197.3	1299.6
32	1186.6	1245.0	1240.1	1334.6
36	1236.0	1280.1	1275.6	1368.7
40	1263.3	1308.8	1302.8	1394.5
44	1288.7	1326.5	1323.6	1419.6
48	1319.0	1347.3	1340.7	1438.7
52	1345.1	1365.7	1361.4	1458.4
56	1367.2	1386.3	1383.4	1480.8
60	1375.5	1398.3	1399.1	1489.2

T E S T R E C O R D D18/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D18/A60 and as shown in ILL. 114.

The fire and hose stream tests were conducted on June 18, 1984.

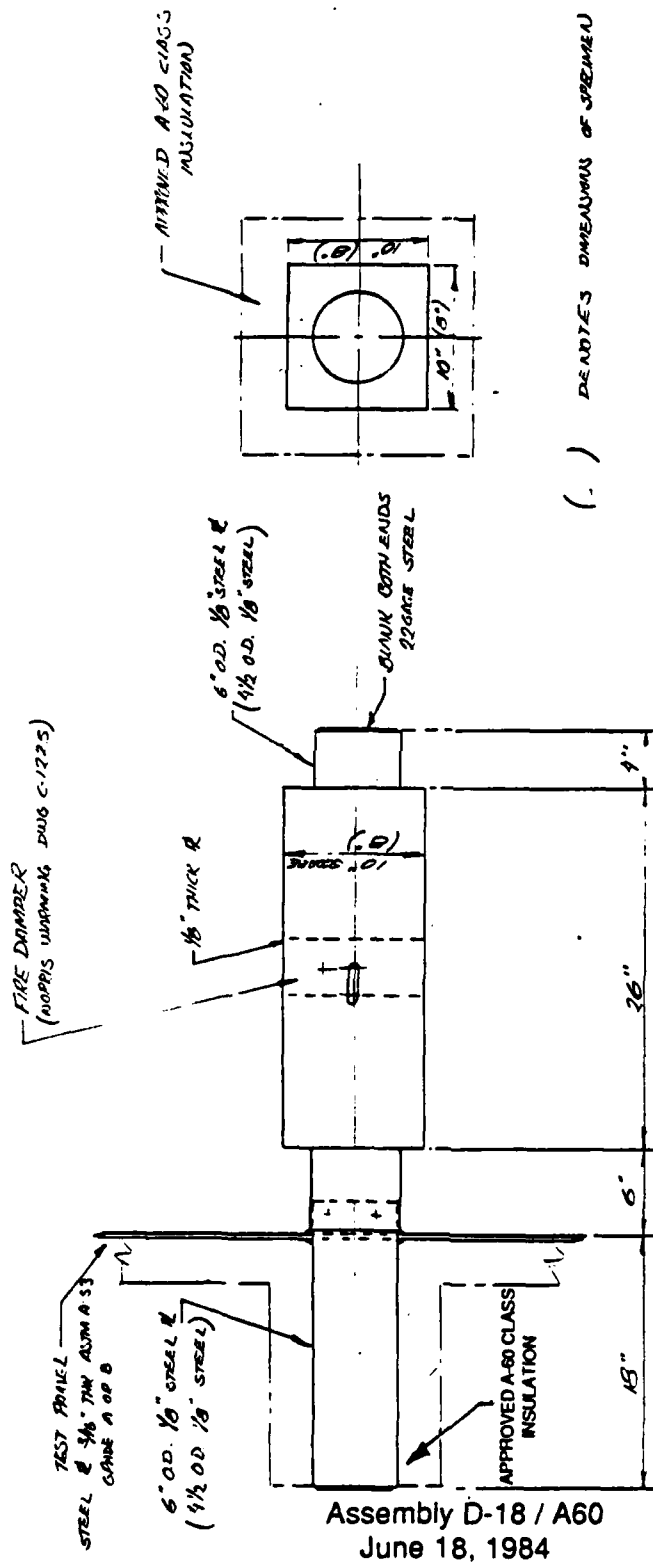
RESULTS

Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 115.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 116 through 116B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



Assembly D-18 / A60
June 18, 1984

(.) DENOTES DIMENSIONS OF SPECIMEN N^o 2

↑
PENETRATION NO D-18
(VENTILATION)

TITLE:	DECK
DATE:	June 84
DESIGNED BY:	
CHECKED BY:	
SCALE:	18" = 1'-0"
REV:	Δ
DWG. NO:	D-18

SAMPLE D-18/A60
TEST DATE JUNE 18, 1984

<u>T.C.</u>	<u>Location</u>
1	Interface of penetrant and unexposed surface.
2	On penetrant, 1 in. above unexposed surface.
3	On penetrant, 6 in. above unexposed surface.
4	On penetrant, 12 in. above unexposed surface.
5	On penetrant, 5 in. below damper.
6	On penetrant, 6 in. above damper.
7	On penetrant, 18 in. above unexposed surface.
8	On penetrant, 24 in. above unexposed surface.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 6 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.
12	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 115

US COAST GUARD D18/A60
6-18-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	83.7	83.7	83.6	83.6
4	85.1	85.6	84.3	84.2
8	91.4	93.1	88.8	86.8
12	102.3	107.7	96.9	92.1
16	117.3	124.1	108.4	98.3
20	133.9	141.8	119.8	106.1
24	153.6	162.3	133.4	114.6
28	176.1	284.5	148.4	123.9
32	202.4	210.8	164.3	134.1
36	231.1	237.2	181.3	144.7
40	258.5	263.1	195.6	155.2
44	286.0	288.8	210.8	165.3
48	312.8	312.9	226.1	174.9
52	337.4	335.5	240.4	183.6
56	358.7	355.3	250.1	192.3
60	379.1	374.0	263.9	200.6

US COAST GUARD D18/A60
6-18-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

5

6

7

8

TIME
(MIN'S)

0	83.7	83.7	83.6	83.6
4	83.7	83.7	84.1	83.7
8	84.6	84.1	86.6	84.1
12	86.0	85.2	91.4	85.1
16	90.8	87.3	96.5	86.8
20	94.3	89.0	103.4	89.2
24	99.6	93.5	111.2	92.2
28	105.4	96.3	119.4	94.6
32	111.9	100.9	128.2	98.7
36	118.8	105.6	137.8	102.9
40	125.9	110.7	147.3	107.5
44	133.4	116.1	156.7	112.5
48	141.0	121.6	166.3	117.4
52	149.1	127.6	175.1	123.0
56	156.8	133.3	183.6	128.2
60	163.6	138.4	191.3	133.1

US COAST GUARD D18/A60
6-18-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
0	83.0	83.9	83.8	83.8
4	83.0	84.1	83.0	84.1
8	85.4	85.0	86.1	86.3
12	88.8	89.7	89.9	89.9
16	93.4	93.7	93.8	93.1
20	99.0	101.5	101.8	100.0
24	109.1	112.9	113.8	110.0
28	121.6	126.7	127.8	122.7
32	135.1	141.3	141.7	136.3
36	148.7	155.6	153.9	149.5
40	166.4	173.7	169.5	162.2
44	183.6	191.1	185.4	176.3
48	200.0	206.2	202.4	189.0
52	214.7	220.5	216.5	200.4
56	229.5	233.4	229.5	213.6
60	243.0	244.6	241.5	224.3

T E S T R E C O R D D19/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D19/A0 and as shown in ILL. 117

The fire and hose stream tests were conducted on June 12, 1984.

RESULTS

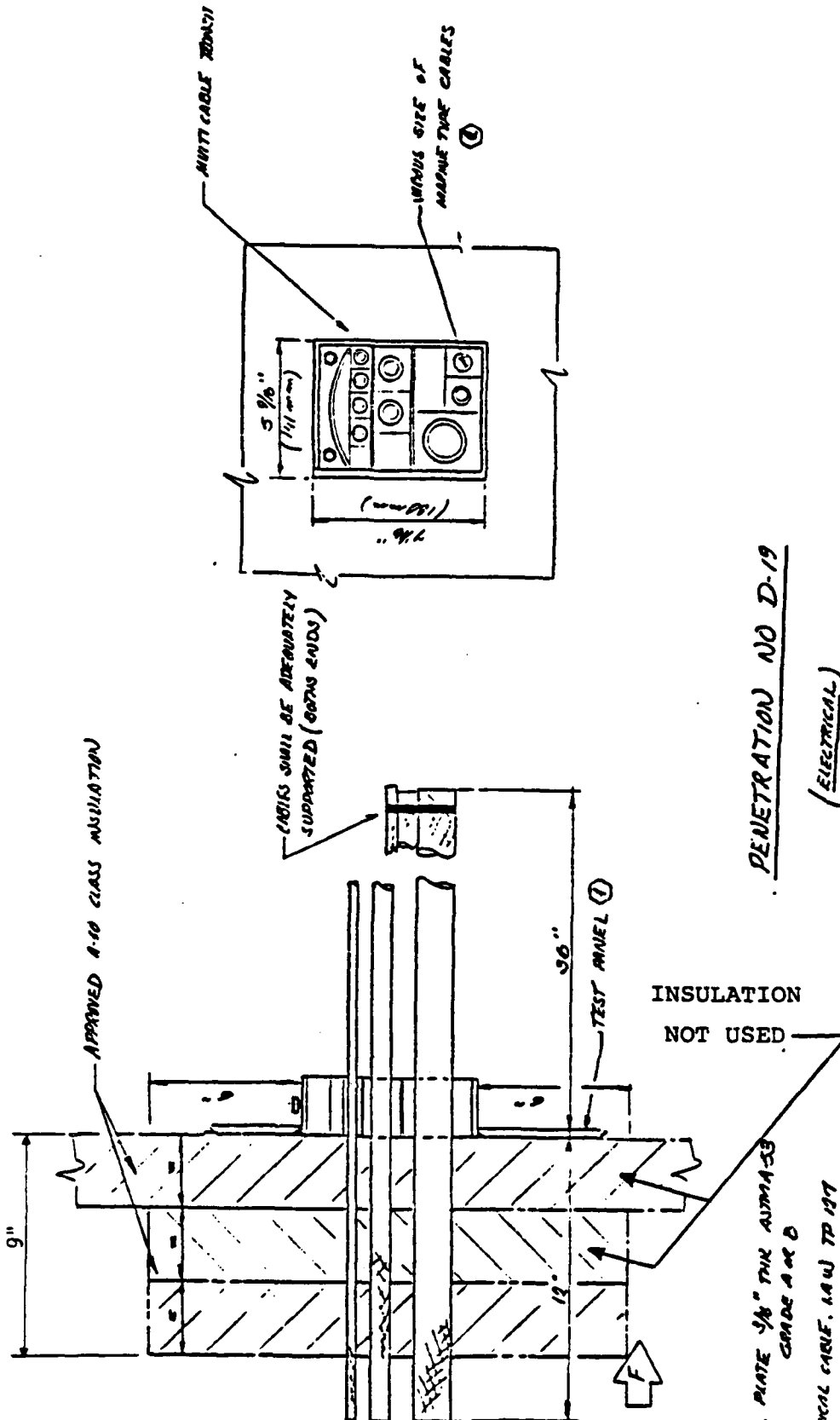
Observations During Fire Test - By 15 min, the cable jackets at the base of the unexposed surface began to swell and issue heavy smoke. By 25 min, heavy smoke was issuing from the cable bundle. By 31 min, the cable jackets at the base of the assembly had ignited. At 32 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILLS. 118 and 118A.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 119 through 119G.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.

CABLE TYPE "1", No Marking - 37 Strands - 3c
 CABLE TYPE "2", Philips 3c 14 AWG XLPE 750V (35c)
 CABLE TYPE "3", 00/00 AWG/3 Canada Wire Mari XBl 750 Volt 1983
 CABLE TYPE "4", No Marking - 3c
 CABLE TYPE "5", Brand-Rex Kana-Tane PRXT 20k 12 AWG 600V
 CABLE TYPE "6", Brand-Rex Polyrad XT 20/c 10 AWG 600 V 125 c°



ASSEMBLY D-19/A0
 JUNE 12, 1984

PENETRATION NO D-19
 (ELECTRICAL)

① STEEL PLATE 3/8" THK ASTM A53 GRADE A AND B
 ② ELECTRICAL CABLE 14W TP 197

TYPE:	DATE:
	EXT. 43
	CONV. BY:
	7/8
PENETRATION	SCALE:
	1
Dwg. No: D-19	
REV. 1	

USNC142

ILL. 117

SAMPLE D-19/AO
TEST DATE JUNE 12, 1984

<u>T.C.</u>	<u>Location</u>
1	On cable jacket, Type "1", 1 in. above grommet.
2	On cable jacket, Type "1", 6 in. above grommet.
3	On cable jacket, Type "1", 12 in. above grommet.
4	On cable jacket, Type "1", 18 in. above grommet.
5	On cable jacket, Type "1", 24 in. above grommet.
6	On cable jacket, Type "2", 1 in. above grommet.
7	On cable jacket, Type "2", 6 in. above grommet.
8	On cable jacket, Type "2", 12 in. above grommet.
9	On cable jacket, Type "2", 18 in. above grommet.
10	On cable jacket, Type "2", 24 in. above grommet.
11	On cable jacket, Type "3", 1 in. above grommet.
12	On cable jacket, Type "3", 6 in. above grommet.
13	On cable jacket, Type "4", 1 in. above grommet.
14	On cable jacket, Type "4", 6 in. above grommet.
15	On cable jacket, Type "5", 1 in. above grommet.
16	On cable jacket, Type "5", 6 in. above grommet.
17	On cable jacket, Type "6", 1 in. above grommet.
18	On cable jacket, Type "6", 6 in. above grommet.
19	On unexposed surface of grommet.
20	On top of grommet fastening screw.
21	On transient compression screw.

USNC142
ILL. 118

Continued.

<u>T.C.</u>	<u>Location</u>
22	On unexposed surface of grommet.
23	On unexposed surface of grommet joint.
24	On unexposed surface of grommet joint.
25	On multi-cable transient frame, 1 in. above unexposed surface.
26	On unexposed surface, at interface of multi-cable transient frame and unexposed surface.
27	On unexposed surface, 6 in. from multi-cable transient frame.
28	On unexposed surface, 12 in. from multi-cable transient frame.
29	On unexposed surface, 1 in. from multi-cable transient frame.
30	On unexposed surface, 6 in. from multi-cable transient frame.
31	On unexposed surface, 12 in. from multi-cable transient frame.

USNC142
ILL. 118A

RMB/KWH:br
lbry

US COAST GUARD 219/A0
6-12-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	96.5	94.3	93.6	92.6
4	118.4	115.1	102.1	95.1
8	189.7	177.7	131.5	105.6
12	297.7	257.2	179.0	124.1
16	400.5	313.3	214.9	142.6
20	538.6	367.6	249.7	161.4
24	706.6	459.9	290.9	183.4
28	829.2	518.5	335.1	208.3
32	865.1	615.8	392.9	238.3

US COAST GUARD D197A0
6-12-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

5

6

7

8

TIME
(MIN'S)

0	92.3	97.0	93.6	93.5
4	94.1	123.0	113.4	103.8
8	101.2	231.8	179.0	141.2
12	113.3	361.0	276.7	201.4
16	125.4	439.5	336.1	246.0
20	138.6	496.6	374.4	277.8
24	154.0	584.4	415.1	311.5
28	172.5	699.9	438.9	333.2
32	196.7	652.5	458.6	360.1

US COAST GUARD D197A0
6-12-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

9

10

11

12

TIME
(MIN'S)

0	92.9	92.8	95.8	93.3
4	96.4	96.0	114.3	108.2
8	111.9	108.4	170.3	153.9
12	139.5	130.4	246.5	215.6
16	163.5	148.3	314.4	261.1
20	184.4	161.7	367.3	293.8
24	208.6	179.3	446.9	317.0
28	229.6	192.7	502.9	349.5
32	252.4	211.4	427.3	379.7

US COAST GUARD D19/A0
6-12-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	13	14	15	16
TIME (MIN'S)				
0	96.1	94.2	95.3	93.3
4	115.1	108.4	108.0	106.3
8	175.8	157.4	145.8	147.1
12	253.4	229.2	205.4	202.8
16	320.9	276.0	258.8	247.0
20	398.7	316.4	321.9	279.9
24	456.5	362.2	382.0	324.3
28	511.4	404.8	446.3	366.7
32	483.4	389.2	435.5	344.1

US COAST GUARD D19/A0
6-12-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	17	18	19	20
TIME (MIN'S)				
0	97.8	94.5	97.8	98.2
4	125.9	114.9	117.3	121.8
8	215.5	183.5	186.6	186.9
12	335.5	277.5	303.3	279.4
16	436.6	340.3	389.9	363.2
20	524.7	406.0	463.6	408.2
24	643.0	473.9	504.3	469.0
28	855.2	536.1	599.5	545.3
32	924.0	677.6	605.3	606.6

US COAST GUARD D19/A0
6-12-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	21	22	23	24
TIME (MIN'S)				
0	102.2	97.9	96.8	100.5
4	162.1	113.0	104.8	121.6
8	323.6	168.6	137.7	176.0
12	554.1	258.8	199.9	246.6
16	692.3	343.4	277.3	300.1
20	771.8	413.2	372.3	356.0
24	834.9	638.7	444.6	413.5
28	879.2	722.4	509.6	479.0
32	908.4	750.3	450.2	458.5

US COAST GUARD D19/A0
6-12-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	25	26	27	28
TIME (MIN'S)				
0	107.2	111.4	112.2	111.0
4	249.5	387.3	197.9	455.7
8	548.3	694.9	332.4	937.2
12	749.1	689.2	396.5	1019.1
16	804.9	735.8	413.9	1074.9
20	760.9	713.6	443.3	1123.8
24	904.0	771.0	464.4	1174.5
28	924.2	734.4	453.9	1222.1
32	623.6	766.9	512.2	1256.7

US COAST GUARD D19/A0
6-12-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	29	30	31
TIME (MIN'S)			
0	113.5	118.5	115.1
4	450.8	486.0	430.3
8	890.6	898.7	798.5
12	1028.3	1006.2	917.5
16	1073.9	1009.7	970.2
20	1105.5	1021.3	1015.5
24	1119.2	996.2	1040.3
28	1123.6	987.0	1076.9
32	1021.4	1008.9	1098.5

T E S T R E C O R D D19/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D19/A60 and as shown on ILL. 120.

The fire and hose stream tests were conducted on June 19, 1984.

RESULTS

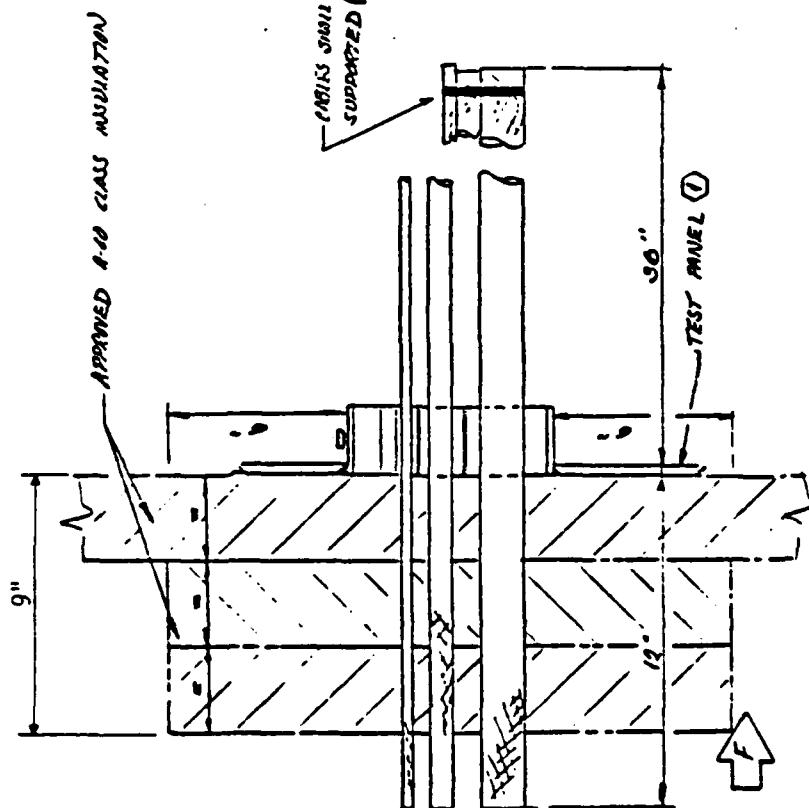
Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILLS. 121 and 121A.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 122 through 122G.

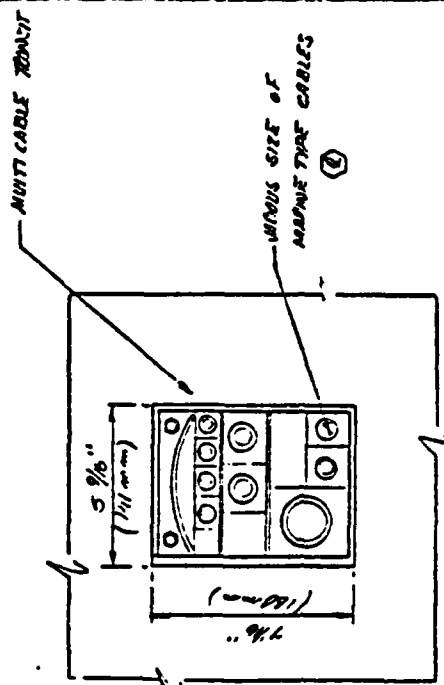
Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.

CABLE TYPE "1", No Marking - 3/ Strands - 3c
 CABLE TYPE "2", Philips 3c 14 AWG XLPE 750V (-350)
 C/ TYPE "3", 00/00 AWG/3 Canada Wire Marine Bl 750 Volt 1983
 CABLE TYPE "4", No Marking - 3c
 CABLE TYPE "5", Brand-Rex Kana-Tane PRXT 20 k 12 AWG 600V
 CABLE TYPE "6", Brand-Rex Polyrad XT 20/c 10 AWG 600 V 125 c



ASSEMBLY D-19/A60

JUNE 19, 1984



MINUS SIZE OF ADAPTOR FOR CABLES

PENETRATION NO D-19

(ELECTRICAL)

① STEEL PLATE 1/8" THK ASTM A36

② ELECTRICAL CABLE, 14W TP 1977

TITLE:	DECK	DATE:	OCT 83
	PENETRATION	DESIGN BY:	7/8
		SCALE:	1
		REV:	1

USNC143

ILL. 120

SAMPLE D-19/A60
TEST DATE JUNE 19, 1984

<u>T.C.</u>	<u>Location</u>
1	On cable jacket, Type "1", 1 in. above grommet.
2	On cable jacket, Type "1", 6 in. above grommet.
3	On cable jacket, Type "1", 12 in. above grommet.
4	On cable jacket, Type "1", 18 in. above grommet.
5	On cable jacket, Type "1", 24 in. above grommet.
6	On cable jacket, Type "2", 1 in. above grommet.
7	On cable jacket, Type "2", 6 in. above grommet.
8	On cable jacket, Type "2", 12 in. above grommet.
9	On cable jacket, Type "2", 18 in. above grommet.
10	On cable jacket, Type "2", 24 in. above grommet.
11	On cable jacket, Type "3", 1 in. above grommet.
12	On cable jacket, Type "3", 6 in. above grommet.
13	On cable jacket, Type "4", 1 in. above grommet.
14	On cable jacket, Type "4", 6 in. above grommet.
15	On cable jacket, Type "5", 1 in. above grommet.
16	On cable jacket, Type "5", 6 in. above grommet.
17	On cable jacket, Type "6", 1 in. above grommet.
18	On cable jacket, Type "6", 6 in. above grommet.
19	On unexposed surface of grommet.
20	On top of grommet fastening screw.
21	On transient compression screw.

USNC142
ILL. 121

Continued.

<u>T.C.</u>	<u>Location</u>
22	On unexposed surface of grommet.
23	On unexposed surface of grommet joint.
24	On unexposed surface of grommet joint.
25	On multi-cable transient frame, 1 in. above unexposed surface.
26	On unexposed surface, at interface of multi-cable transient frame and unexposed surface.
27	On unexposed surface, 6 in. from multi-cable transient frame.
28	On unexposed surface, 12 in. from multi-cable transient frame.
29	On unexposed surface, 1 in. from multi-cable transient frame.
30	On unexposed surface, 6 in. from multi-cable transient frame.
31	On unexposed surface, 12 in. from multi-cable transient frame.

USNC142
ILL. 121A

US COAST GUARD D19/A60
6-19-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	81.2	81.3	81.2	80.9
4	81.0	82.1	81.9	81.4
8	84.8	83.6	82.8	81.0
12	90.4	86.3	83.9	82.6
16	97.7	90.9	85.0	83.5
20	108.0	96.1	88.0	84.9
24	119.9	104.0	92.0	86.0
28	133.4	113.3	96.8	89.5
32	148.1	123.6	102.5	92.6
36	164.1	135.2	108.9	95.1
40	179.4	147.2	116.0	99.1
44	193.1	160.2	123.6	103.6
48	207.0	173.5	132.0	108.9
52	225.7	186.5	140.2	114.2
56	241.8	197.5	148.3	120.0
60	256.4	208.6	156.8	125.4

US COAST GUARD D19/A60
6-19-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	81.2	79.8	79.4	79.8
4	81.7	80.2	79.9	79.0
8	82.4	80.2	79.0	80.2
12	83.3	80.4	80.1	80.2
16	84.2	81.7	80.9	80.8
20	85.6	83.6	81.9	81.6
24	87.3	86.9	84.1	82.0
28	89.3	89.8	85.8	84.3
32	91.6	93.8	87.0	85.7
36	93.3	98.4	90.5	87.1
40	96.3	104.8	93.3	87.6
44	99.6	110.3	94.9	89.4
48	103.5	118.0	98.2	92.3
52	107.6	124.9	101.6	93.5
56	111.8	130.5	103.6	95.1
60	116.1	135.7	105.2	96.1

USNC142
ILL. 122A

US COAST GUARD D197A60
6-12-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
0	80.1	80.3	80.0	80.0
4	80.1	80.5	81.2	81.4
8	80.3	80.9	82.3	81.0
12	80.2	81.2	84.7	83.1
16	80.8	82.2	88.9	85.3
20	81.6	83.3	93.3	88.1
24	82.0	84.7	99.6	91.8
28	83.0	85.8	107.0	95.1
32	85.2	86.0	115.4	99.8
36	86.3	87.0	124.6	105.0
40	87.5	89.1	134.3	110.9
44	88.8	90.2	146.9	117.9
48	90.3	91.6	158.0	125.2
52	92.2	93.4	170.8	132.9
56	93.7	93.7	184.6	141.0
60	93.5	94.9	197.3	149.7

US COAST GUARD D19/A60
6-19-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	13	14	15	16
TIME (MIN'S)				
0	85.0	79.9	80.1	79.9
4	89.5	79.0	80.3	79.9
8	95.7	80.1	80.4	79.8
12	107.9	80.6	81.3	79.9
16	118.1	82.4	83.8	80.9
20	116.1	84.8	87.4	82.6
24	106.4	88.2	92.9	85.5
28	111.1	92.2	97.6	88.8
32	111.7	95.6	105.2	93.2
36	111.4	100.3	114.5	97.5
40	115.6	105.4	125.7	103.7
44	120.3	111.0	137.1	110.4
48	119.9	116.8	152.4	118.8
52	128.2	123.6	164.8	127.7
56	127.5	129.7	173.4	135.5
60	148.6	136.2	180.2	145.0

US COAST GUARD B19/A60
6-19-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	17	18	19	20
TIME (MIN'S)				
0	80.8	80.7	80.8	80.5
4	81.5	81.4	80.8	80.7
8	82.9	82.3	80.0	80.8
12	86.3	83.9	81.3	80.0
16	92.2	86.8	82.1	81.6
20	99.9	91.4	83.8	82.7
24	111.2	96.6	86.3	84.5
28	125.2	104.3	89.0	86.9
32	148.2	115.5	93.6	90.2
36	175.2	134.8	99.5	93.1
40	187.6	149.3	107.1	97.7
44	192.9	163.5	114.0	103.0
48	196.1	172.1	122.7	108.7
52	202.2	179.5	128.8	115.0
56	208.1	186.2	137.8	121.1
60	217.8	193.0	143.5	127.5

US COAST GUARD D19/A60
6-19-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	21	22	23	24
TIME (MIN'S)				
0	80.8	80.9	80.6	80.0
4	80.0	80.0	80.7	81.1
8	81.4	81.2	80.8	81.6
12	82.2	81.6	81.4	83.1
16	83.7	82.6	83.2	86.1
20	86.4	84.5	85.8	90.4
24	90.7	87.7	89.0	94.9
28	95.5	91.0	93.8	102.0
32	102.6	96.9	100.2	110.7
36	111.1	104.7	108.1	120.3
40	121.2	113.8	116.5	130.2
44	130.3	122.8	125.6	141.9
48	140.2	132.4	135.6	152.8
52	150.2	142.5	146.3	166.1
56	159.6	153.1	155.9	180.6
60	169.1	163.5	164.3	195.3

US COAST GUARD B19/A60
6-19-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	25	26	27	28
TIME (MIN'S)				
0	81.5	81.4	81.7	81.7
4	81.6	81.7	82.2	82.4
8	82.2	82.6	83.0	84.7
12	83.5	84.3	86.9	88.3
16	85.8	87.3	91.8	93.7
20	89.5	92.3	98.9	100.6
24	93.9	98.5	110.2	111.2
28	101.5	107.5	123.5	124.0
32	111.2	117.9	136.8	137.3
36	121.8	128.2	149.4	150.7
40	132.4	138.5	164.5	166.5
44	142.9	149.6	178.1	180.7
48	154.1	161.9	190.7	194.0
52	167.0	173.6	201.7	206.2
56	179.8	184.2	211.0	216.7
60	192.5	194.5	219.1	225.8

US COAST GUARD D19/A60
6-19-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	29	30	31
TIME (MIN'S)			
0	81.4	81.6	81.5
4	81.6	82.2	82.2
8	82.4	84.4	84.7
12	84.2	88.2	88.0
16	87.7	95.1	95.2
20	93.5	107.6	106.9
24	100.8	123.1	122.1
28	110.8	139.0	138.1
32	121.5	153.8	152.8
36	131.7	170.8	171.8
40	143.2	186.9	190.1
44	156.4	201.9	208.0
48	168.8	216.5	223.9
52	181.9	231.1	239.7
56	194.9	246.2	255.3
60	206.6	261.7	270.6

T E S T R E C O R D D20/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D20/A0 and as shown in ILL. 123.

The fire and hose stream tests were conducted on June 8, 1984.

RESULTS

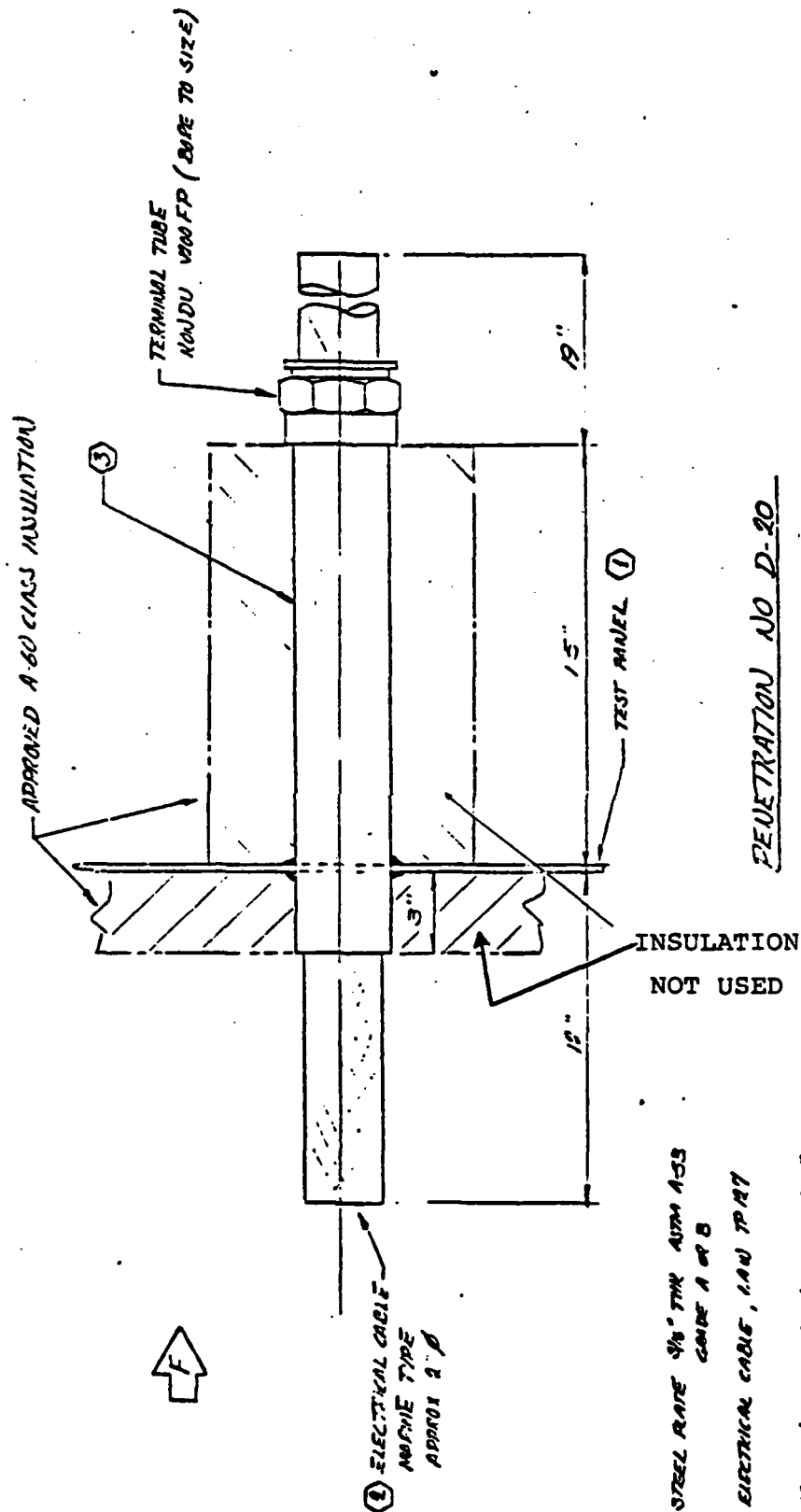
Observations During Fire Test - By 45 min, the unexposed surface of the deck was glowing red.

No significant changes occurred during the remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 124.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 125 through 125B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-29/A0

JUNE 8, 1984

C-271

- ① STEEL PLATE 1/2" THK ASTM A33 GRADE A OR B
- ② ELECTRICAL CABLE, LOW TYPIC APPROX 2" Ø
- ③ 2" SCH 40, STANDARD STEEL PIPE ASTM A33 GRADE A OR B

PENETRATION NO D-20

(ELECTRICAL)

TITLE:	DECK	DATE:	ATAS
	PENETRATION	REVISION:	75
		SCALE:	
		BY:	

USNC142

ILL. 123

SAMPLE D-20/AO
TEST DATE JUNE 8, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 12 in. above unexposed surface.
4	On penetrant, at interface of steel pipe and terminal tube.
5	On penetrant, at interface of steel pipe and cable.
6	On penetrant, 24 in. above unexposed surface.
7	On unexposed surface, at interface of penetrant and unexposed surface.
8	On unexposed surface, 6 in. from penetrant.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 12 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 124

US COAST GUARD D20/A0
6-8-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	96.4	90.8	90.6	90.5
4	265.8	114.4	99.0	94.2
8	498.7	207.3	139.5	115.3
12	646.0	317.3	198.8	150.0
16	727.0	398.4	251.1	186.8
20	787.1	459.7	298.3	221.8
24	824.9	506.3	334.8	253.5
28	854.3	546.2	367.1	282.1
32	880.2	579.6	398.7	307.7
36	909.5	613.7	430.5	332.9
40	934.6	644.4	459.5	357.9
44	951.2	665.6	479.3	378.8
48	959.0	674.6	492.1	397.1
52	963.4	681.2	504.4	416.8
56	961.8	677.4	514.5	432.2
60	969.4	683.5	520.3	442.8

US COAST GUARD D20/A0
6-8-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	90.2	90.5	102.5	109.6
4	92.4	93.1	407.6	494.0
8	102.0	107.2	791.8	919.7
12	123.4	126.5	943.3	1077.5
16	150.5	143.8	1011.3	1138.0
20	179.9	159.5	1054.9	1190.0
24	210.8	173.9	1069.4	1222.7
28	241.3	189.2	1089.4	1269.8
32	262.1	216.7	1121.6	1308.2
36	285.9	227.0	1155.6	1331.8
40	310.2	239.2	1176.5	1351.1
44	334.1	253.0	1187.8	1364.2
48	351.5	263.6	1197.1	1364.4
52	371.3	276.6	1206.6	1380.9
56	392.6	292.9	1218.5	1396.0
60	406.8	304.4	1220.1	1392.4

US COAST GUARD L20/A0
6-8-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

9

10

11

TIME
(MIN'S)

0	104.5	108.5	110.5
4	504.8	407.8	411.9
8	955.9	791.4	825.7
12	1082.1	981.9	997.0
16	1136.2	1053.1	1067.8
20	1189.3	1111.2	1129.6
24	1214.4	1148.9	1165.7
28	1244.0	1199.1	1208.0
32	1274.9	1250.3	1251.2
36	1299.8	1289.6	1288.8
40	1312.8	1317.4	1311.0
44	1323.1	1340.1	1329.8
48	1311.3	1352.9	1337.6
52	1312.0	1378.3	1364.5
56	1310.9	1404.3	1386.6
60	1307.8	1410.3	1398.6

T E S T R E C O R D D20/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D20/A60 and as shown on ILL. 126.

The fire and hose stream tests were conducted on July 18, 1984.

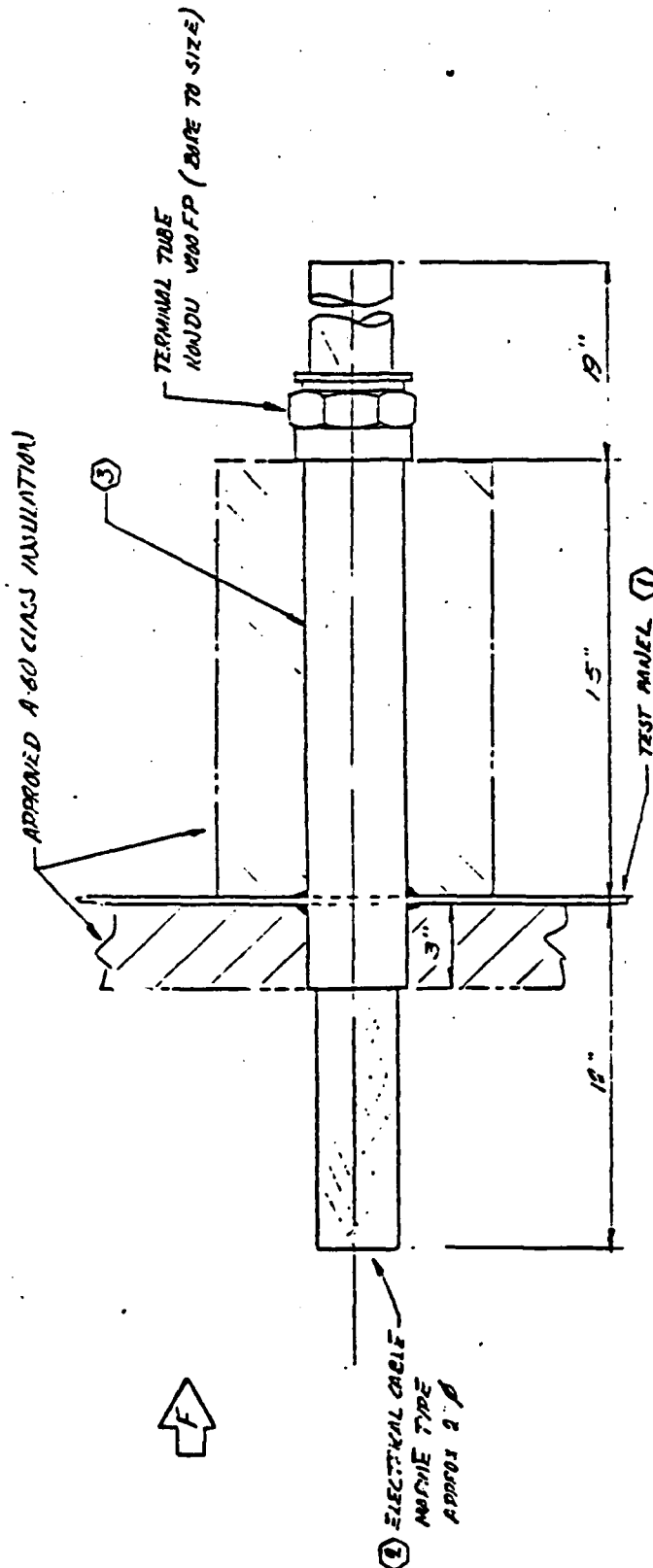
RESULTS

Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 127.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 128 through 128C.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-20/A60

JULY 18, 1984

C-277

- (1) STEEL PLATE $\frac{3}{4}$ " THK ASTM A53 GRADE A OR B
- (2) ELECTRICAL CABLE, 14 AWG TP147
- (3) 2" SCH 40, SEAMLESS STEEL PIPE ASTM A53 GRADE A OR B

PENETRATION NO D-20

(ELECTRICAL)

TITLE:	DECK
DATE:	2/7/83
BY:	7/3
SCALE:	
REV:	1
FILE NO:	D-20

USNC142

ILL. 126

SAMPLE D-20/A60
TEST DATE JULY 18, 1984

<u>T.C.</u>	<u>Location</u>
1	On penetrant, 1 in. above unexposed surface.
2	On penetrant, 6 in. above unexposed surface.
3	On penetrant, 12 in. above unexposed surface.
4	On penetrant, at interface of steel pipe and terminal tube.
5	On penetrant, at interface of steel pipe and cable.
6	On penetrant, 24 in. above unexposed surface.
7	On unexposed surface, at interface of penetrant and unexposed surface.
8	On unexposed surface, 6 in. from penetrant.
9	On unexposed surface, 6 in. from penetrant.
10	On unexposed surface, 12 in. from penetrant.
11	On unexposed surface, 12 in. from penetrant.
12	On penetrant insulation, 1 in. above unexposed surface.
13	On penetrant insulation, 6 in. above unexposed surface.
14	On penetrant insulation, 12 in. above unexposed surface.

USNC142
ILL. 127

US COAST GUARD D20/A60
7-18-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

1

2

3

4

TIME
(MIN'S)

0	77.9	76.9	76.8	77.3
4	83.5	77.3	76.0	77.5
8	92.9	79.1	77.5	78.1
12	108.5	83.5	78.4	78.6
16	128.2	91.4	80.7	79.8
20	151.3	101.6	84.7	81.7
24	176.8	116.6	90.5	84.6
28	206.9	136.4	97.5	88.9
32	241.1	157.1	108.8	94.0
36	277.4	178.5	125.2	101.4
40	312.5	202.1	141.9	111.7
44	345.3	228.4	156.8	125.8
48	376.5	254.3	171.8	139.1
52	406.3	280.2	187.3	150.4
56	434.6	305.8	203.4	160.9
60	460.9	329.7	220.4	170.3

US COAST GUARD D20/A60
7-18-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

5

6

7

8

TIME
(MIN'S)

0	77.7	78.1	77.0	80.7
4	77.9	78.3	84.8	80.8
8	78.6	78.0	94.9	82.9
12	79.5	79.7	111.1	86.9
16	81.3	80.9	131.1	93.1
20	83.0	82.6	153.9	104.9
24	87.0	85.2	180.3	119.9
28	93.5	88.5	211.7	135.6
32	99.3	93.3	246.9	152.9
36	106.3	97.1	283.0	172.6
40	114.0	102.6	317.4	191.6
44	129.5	109.6	349.8	209.7
48	167.3	119.6	380.5	227.2
52	178.4	133.0	409.5	242.7
56	180.4	143.6	436.7	256.9
60	180.1	165.4	461.8	270.0

US COAST GUARD D20/A60
7-18-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	9	10	11	12
TIME (MIN'S)				
0	78.5	78.6	78.7	78.7
4	79.1	79.5	79.5	79.1
8	81.5	82.1	81.9	80.8
12	85.4	85.0	85.4	82.9
16	92.0	93.3	92.5	86.5
20	103.9	103.6	102.6	90.7
24	120.0	117.6	116.7	95.1
28	137.0	131.6	131.0	102.2
32	154.9	145.3	145.1	112.9
36	175.6	161.2	161.1	120.6
40	195.7	177.0	176.1	129.7
44	213.8	191.7	190.3	144.2
48	230.6	204.9	203.3	153.4
52	245.5	216.9	215.7	164.5
56	258.8	228.0	227.6	169.7
60	271.4	238.1	237.5	181.1

US COAST GUARD D20/A&O
7-18-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

13

14

TIME
(MIN'S)

0	78.6	78.9
4	78.7	79.2
8	79.5	80.5
12	80.4	81.7
16	81.9	83.2
20	83.4	84.6
24	85.3	85.8
28	87.0	87.3
32	91.4	89.1
36	93.6	90.6
40	95.8	92.3
44	100.5	93.4
48	105.2	95.4
52	110.4	97.8
56	112.7	99.2
60	117.8	101.7

T E S T R E C O R D D21/A0

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D21/A0 and as shown in ILL. 129.

The fire and hose stream tests were conducted on June 5, 1984.

RESULTS

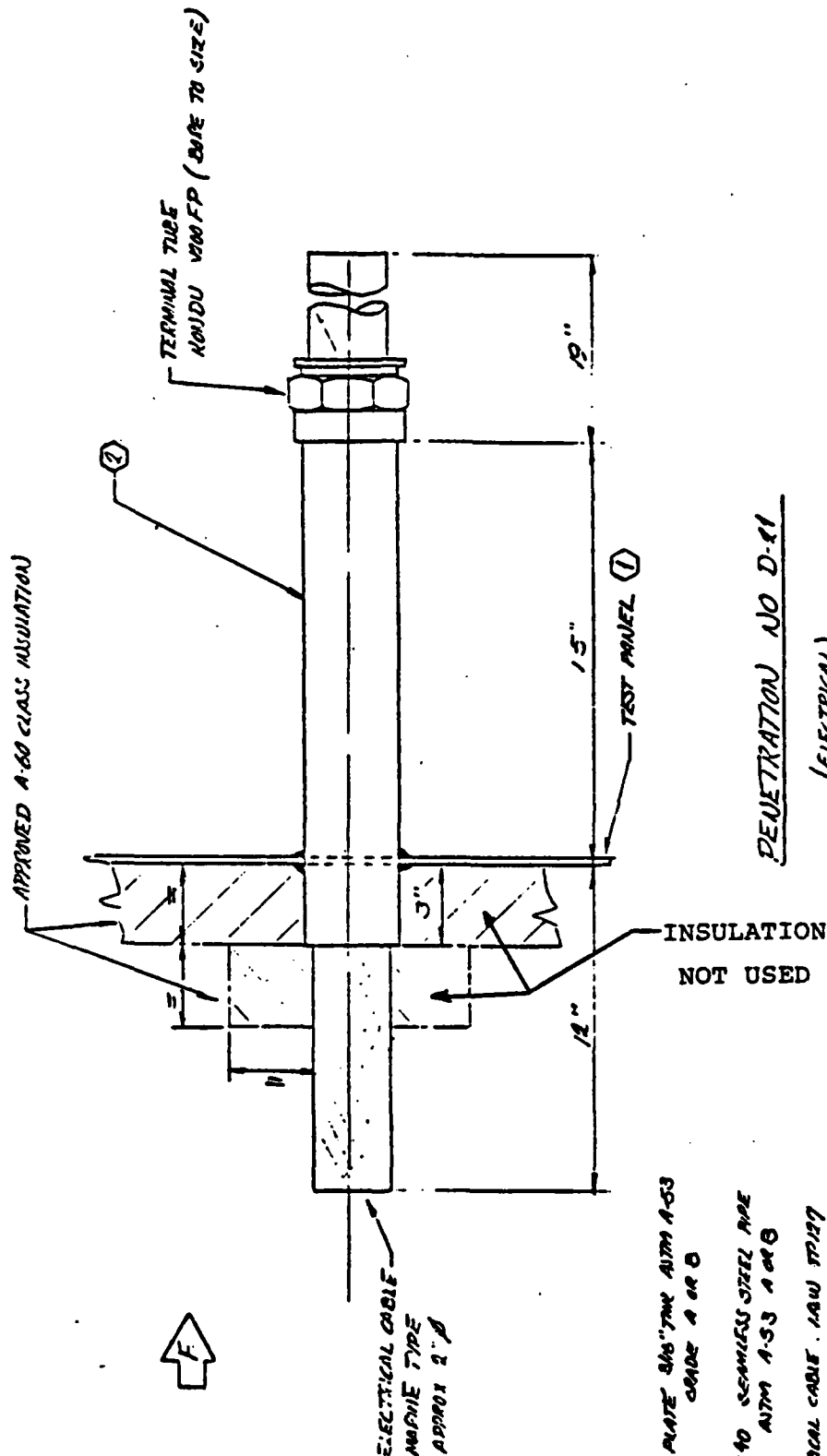
Observations During Fire Test - By 45 min, the unexposed surface of the deck was glowing red.

No significant changes occurred during the remainder of the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 130.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 131 through 131B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-21/A0

JUNE 5, 1984

- ① STEEL PLATE 3/16" THK WITH A-53 GRADE A OR B
- ② 2" DIA 40 SEAMLESS STEEL PIPE WITH A-53 A OR B
- ③ ELECTRICAL CABLE, 14AW STP127

PENETRATION NO D-41
(ELECTRICAL)

TITLE:	DECK
DATE:	5-7-83
DESIGNED BY:	7/3
SCALE:	1" = 1'
DWG NO:	D-41

USNC142

ILL. 129

SAMPLE D-21/AO
TEST DATE JUNE 5, 1984

<u>T.C.</u>	<u>Location</u>
1	Interface of penetrant and unexposed surface.
2	On penetrant, 1 in. above unexposed surface.
3	On penetrant, 6 in. above unexposed surface.
4	On penetrant, 12 in. above unexposed surface.
5	On penetrant, 18 in. above unexposed surface.
6	On penetrant, 24 in. above unexposed surface.
7	On unexposed surface, 6 in. from penetrant.
8	On unexposed surface, 6 in. from penetrant.
9	On unexposed surface, 12 in. from penetrant.
10	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 130

US COAST GUARD D21/A0
6-5-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

	1	2	3	4
TIME (MIN'S)				
0	87.5	85.9	83.0	83.8
4	352.8	227.1	105.2	91.5
8	725.6	446.8	188.8	122.9
12	911.5	619.8	297.5	177.1
16	993.6	707.1	377.7	225.6
20	1051.5	756.3	435.9	268.2
24	1095.3	800.7	486.6	307.2
28	1114.5	825.5	521.0	333.3
32	1133.7	851.3	556.3	363.8
36	1156.9	872.1	586.5	388.7
40	1173.9	891.6	607.0	414.6
44	1191.8	913.0	637.2	441.4
48	1204.5	922.4	650.0	459.6
52	1222.2	939.7	668.1	477.3
56	1227.9	937.6	669.8	486.6
60	1240.8	945.9	674.1	496.3

US COAST GUARD D21/A0
6-5-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	83.6	83.0	89.2	89.4
4	86.7	87.6	420.6	450.8
8	97.5	100.3	905.7	890.8
12	115.0	119.5	1065.5	1047.6
16	132.9	136.7	1117.3	1097.4
20	154.3	152.3	1140.2	1145.7
24	179.4	168.5	1137.9	1186.0
28	208.2	183.4	1130.1	1219.0
32	226.7	214.8	1137.0	1256.5
36	250.2	224.4	1157.6	1292.2
40	272.9	229.7	1179.1	1321.8
44	297.7	243.7	1189.1	1352.9
48	319.1	256.1	1190.9	1380.9
52	330.2	271.0	1194.7	1403.1
56	320.6	283.7	1203.6	1420.4
60	328.4	300.2	1213.2	1437.1

US COAST GUARD D21/A0
6-5-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

9

10

TIME
(MIN'S)

0	88.5	89.5
4	331.7	335.3
8	706.0	725.3
12	921.5	939.9
16	1007.0	1031.8
20	1062.3	1084.5
24	1110.5	1137.0
28	1146.3	1165.9
32	1184.1	1206.0
36	1221.7	1248.9
40	1263.6	1277.4
44	1291.4	1303.6
48	1314.5	1324.0
52	1336.6	1350.5
56	1364.7	1379.7
60	1383.8	1400.7

T E S T R E C O R D D21/A60

SAMPLE:

The fire and hose stream tests were conducted on the assembly identified as D21/A60 and as shown on ILL. 132.

The fire and hose stream tests were conducted on June 20, 1984.

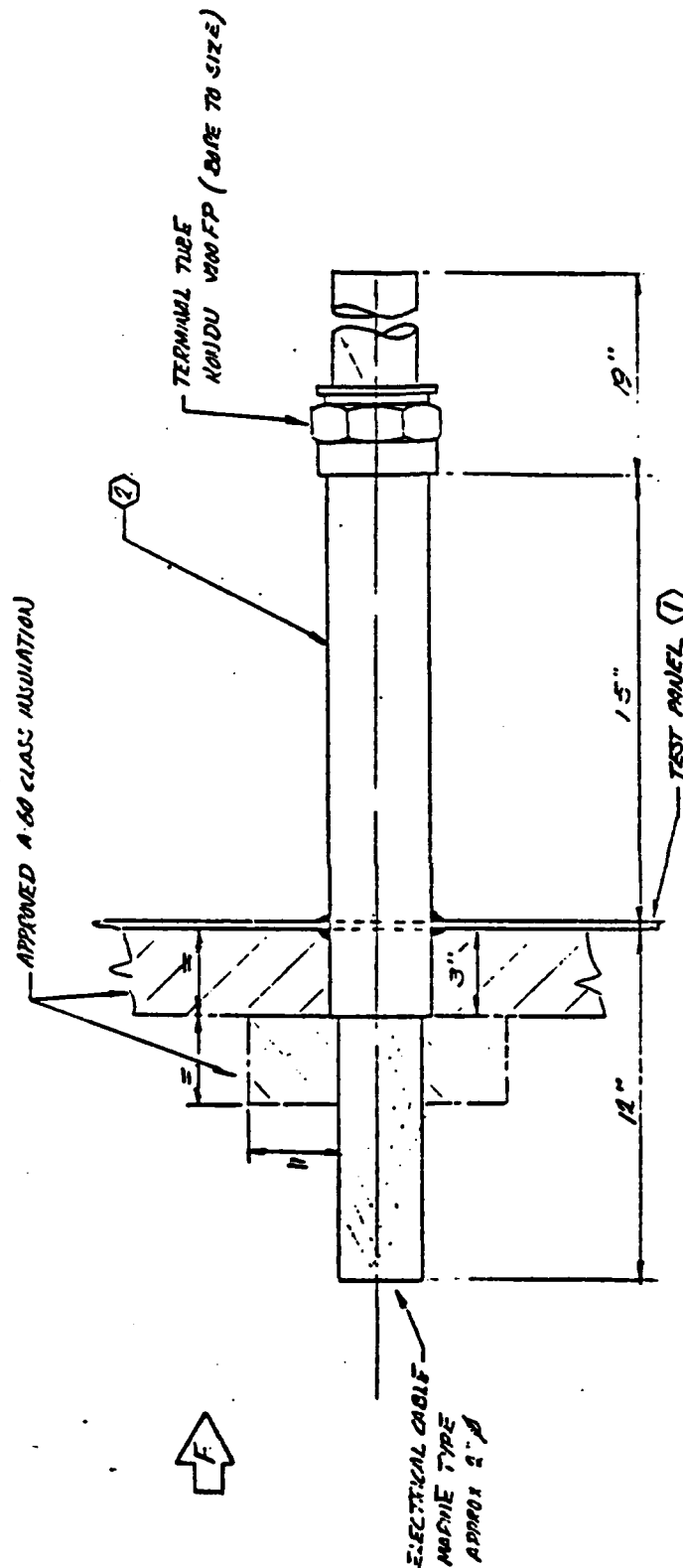
RESULTS

Observations During Fire Test - No significant changes occurred during the fire test. At 60 min, the furnace fire was extinguished.

Temperature Of The Assembly - The locations of the thermocouples to measure the various temperatures on the deck assembly are shown in ILL. 133.

The temperatures recorded during the fire test on the unexposed surfaces and on the deck are shown on ILLS. 134 through 134B.

Pictorial History - Photographs were obtained during the fire test, during the hose stream test, and after the hose stream test.



ASSEMBLY D-21/A60
JUNE 20, 1984

- ① STEEL PLATE 3/16" THK ASTM A-53 GRADE A OR B
- ② 2" DIA 40 SEMI-STEEL PIPE ASTM A-53 A OR B
- ③ ELECTRICAL CABLE, LOW VOLTAGE

PENETRATION NO D-21
(ELECTRICAL)

TITLE:	DECK	DATE:	2-7-83
	PENETRATION	DESIGNED BY:	7/3
		CHECKED BY:	
		DATE:	11/1

USNC142

ILL. 132

SAMPLE D-21/A60
TEST DATE JUNE 20, 1984

<u>T.C.</u>	<u>Location</u>
1	Interface of penetrant and unexposed surface.
2	On penetrant, 1 in. above unexposed surface.
3	On penetrant, 6 in. above unexposed surface.
4	On penetrant, 12 in. above unexposed surface.
5	On penetrant, 18 in. above unexposed surface.
6	On penetrant, 24 in. above unexposed surface.
7	On unexposed surface, 6 in. from penetrant.
8	On unexposed surface, 6 in. from penetrant.
9	On unexposed surface, 12 in. from penetrant.
10	On unexposed surface, 12 in. from penetrant.

USNC142
ILL. 133

US COAST GUARD B217A40
6-20-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	1	2	3	4
TIME (MIN'S)				
0	73.5	73.3	73.3	73.2
4	74.1	73.7	73.7	73.5
8	75.7	74.3	74.1	73.9
12	78.0	75.8	74.0	74.6
16	84.2	78.2	76.2	75.6
20	91.1	81.8	77.8	76.8
24	99.0	86.4	80.1	78.5
28	108.8	90.9	81.9	79.0
32	123.1	97.5	85.7	82.9
36	136.5	104.3	88.7	85.4
40	153.8	112.9	92.8	88.6
44	171.1	123.8	97.1	92.8
48	184.2	133.6	101.7	95.5
52	198.4	144.4	107.9	100.5
56	211.5	154.1	114.4	105.8
60	225.7	163.8	121.9	111.6

US COAST GUARD D21/A60
6-20-84
UNEXPOSED SURFACE

THERMOCOUPLE (NO'S)	5	6	7	8
TIME (MIN'S)				
0	73.4	75.7	73.9	73.9
4	73.6	75.5	74.6	74.6
8	74.1	77.3	77.3	77.1
12	74.8	80.6	82.4	81.5
16	75.9	85.7	93.5	89.9
20	76.9	92.9	109.8	101.7
24	78.2	102.0	129.5	117.8
28	79.2	110.5	144.8	133.0
32	81.1	128.3	161.7	147.2
36	82.0	137.8	178.3	162.9
40	84.9	156.5	194.3	178.2
44	87.7	166.1	209.6	193.5
48	89.0	182.1	223.1	207.2
52	92.0	197.1	235.7	220.2
56	95.2	212.4	247.1	231.8
60	99.1	226.1	257.1	242.3

US COAST GUARD 2217A60
6-20-84
UNEXPOSED SURFACE

THERMOCOUPLE
(NO'S)

9

10

TIME
(MIN'S)

0	72.8	73.1
4	73.6	74.2
8	75.9	76.7
12	80.6	80.4
16	90.3	85.8
20	103.9	92.8
24	119.4	102.8
28	130.2	113.0
32	144.5	124.0
36	157.0	133.7
40	172.5	143.5
44	188.1	154.3
48	201.9	161.9
52	217.5	174.3
56	234.9	188.2
60	250.2	201.0

END

FILMED

2-86

DTIC